California Regional Water Quality Control Board
Santa Ana Region

April 15, 2005

Item: **5**

Subject: **Consideration of Approval of the Surface Water and Groundwater Monitoring Programs Submitted in Compliance with the Total Dissolved Solids (TDS) and Nitrogen Management Plan Specified in the Water Quality Control Plan for the Santa Ana River Basin – Resolution No. R8-2005-0063**

DISCUSSION

On January 22, 2004, the Regional Board adopted Resolution No. R8-2004-0001, amending the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) to incorporate a revised Total Dissolved Solids (TDS) and Nitrogen Management Plan. The revised Total Dissolved Solids and Nitrogen Management Plan addresses total dissolved solids (TDS) and nitrogen in both surface waters and groundwaters throughout the Santa Ana River basin.

The TDS and Nitrogen Management Plan requires the TDS and Nitrogen Task Force (specified water supply and wastewater agencies) to submit proposed plans for surface and groundwater monitoring throughout the Santa Ana River basin. The purpose of the surface water monitoring program is to determine compliance with TDS and nitrogen Basin Plan objectives for the Santa Ana River and tributaries of the Santa Ana River. Data collected pursuant to the groundwater monitoring program will be used to determine ambient TDS and nitrate nitrogen water quality to evaluate compliance with Basin Plan TDS and nitrate nitrogen objectives, and to update assimilative capacity findings for each management zone. The groundwater monitoring programs, and to some extent, the surface water monitoring program, will be used to confirm the 50% nitrogen loss coefficient specified in the Basin Plan for the Santa Ana River, Reach 3.

In compliance with these Total Dissolved Solids and Nitrogen Management Plan requirements, in a report dated February, 2004, the Task Force submitted for Regional Board review and approval a proposed groundwater monitoring program. On June 3, 2004, and in a July 2004 addendum to the June 3, 2004 submittal, the Task Force submitted a proposed plan for the confirmation of the 50% nitrogen loss coefficient for the Santa Ana River, Reach 3. In a letter dated January 28, 2005, the Task Force submitted for Regional Board review and approval a proposed surface water monitoring program. These proposed monitoring programs are attached to Resolution No. R8-2005-0063. To a large degree, the proposed programs rely on monitoring efforts already established and underway. Staff has reviewed the proposed monitoring programs and finds that they satisfy the TDS and Nitrogen Management Plan Monitoring Program requirements.

The TDS and Nitrogen Management Plan also specifies dates for reporting the results of these monitoring programs by the Task Force. An annual report of the surface water quality is to be submitted by April 15th of each year. The determination of current ambient groundwater quality throughout the watershed must be reported by July 1, 2005, and, at a minimum, every three years thereafter. The Task Force expects to comply with these reporting requirements.

STAFF RECOMMENDATION

Adopt Resolution No. R8-2005-0063, approving the Surface Water and Groundwater Monitoring Programs shown in the attachment to the Resolution.

California Regional Water Quality Control Board
Santa Ana Region

RESOLUTION NO. R8-2005-0063

Resolution Approving the Surface Water and Groundwater Monitoring Program Proposals as Required in the Total Dissolved Solids and Nitrogen Management Plan Specified in the Water Quality Control Plan for the Santa Ana River Basin

WHEREAS, the California Regional Water Quality Control Board, Santa Ana Region (hereinafter Regional Board), finds that:

1. An updated Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) was adopted by the Regional Board on March 11, 1994, approved by the State Water Resources Control Board (SWRCB) on July 21, 1994, and approved by the Office of Administrative Law (OAL) on January 24, 1995.

2. Amendments to the Basin Plan to incorporate a revised Total Dissolved Solids and Nitrogen Management Plan into the 1995 Basin Plan were approved by the Regional Board on January 22, 2004, by the State Water Resources Control Board on October 1, 2004 and by the Office of Administrative Law on December 23, 2004. The surface water components of the amendments are awaiting approval by the U. S. Environmental Protection Agency (EPA). It is neither appropriate nor necessary to await EPA approval to consider approval, and thereby trigger implementation, of monitoring programs designed to assess water quality conditions in the Region.

3. The Total Dissolved Solids and Nitrogen Management Plan addresses total dissolved solids (TDS) and nitrogen in both surface waters and groundwaters throughout the Santa Ana River basin.

4. The Total Dissolved Solids and Nitrogen Management Plan (Section V. Salt Management Plan – Monitoring Program Requirements, A.) requires specified affected water supply and wastewater agencies (hereinafter, Task Force) to submit by March 23, 2005 a proposed surface water monitoring program for Regional Board approval. The Plan requires that the Task Force implement the program upon Regional Board approval.

5. The Total Dissolved Solids and Nitrogen Management Plan (Section V. Salt Management Plan – Monitoring Program Requirements, B.) requires the Task Force to submit by June 23, 2005 a proposed groundwater monitoring program for Regional Board approval. The Plan requires that the Task Force implement the program within 30 days of Regional Board approval.

6. Section V. Salt Management Plan – Monitoring Requirements identifies the data collection and analytical needs that must be addressed by the proposed ground and surface water monitoring programs. These include the determination of Santa Ana River Reach 2, 4 and 5 water quality and current ambient groundwater quality, and confirmation of the 50% nitrogen loss coefficient specified for discharges to the Santa Ana River, Reach 3. The Plan also specifies dates for reporting the results of the monitoring programs.

7. In compliance with these Basin Plan Total Dissolved Solids and Nitrogen Management Plan requirements, in a report dated February, 2004, the Task Force submitted for Regional Board review and approval a proposed groundwater monitoring program. On June 3, 2004, and in a July 2004 addendum to the June 3, 2004 submittal, the Task Force submitted a proposed plan for the confirmation of the 50% nitrogen loss coefficient for the Santa Ana River, Reach 3. In a letter dated January 28, 2005, the Task Force submitted for Regional Board review and approval a proposed surface water monitoring program.

8. The Task Force is implementing the proposed surface and ground water monitoring programs and expects to comply with the reporting dates identified in the Basin Plan (Salt Management Plan – Monitoring Program Requirements).

9. The Regional Board has reviewed the proposed monitoring programs and finds that they comply with the Salt Management Plan – Monitoring Program Requirements specified in the Basin Plan.

NOW, THEREFORE, BE IT RESOLVED THAT:

The Regional Board approves the surface water monitoring program, groundwater monitoring program, and the nitrogen loss monitoring program submitted by the Task Force in February 2004, June 3, 2004, July 2004 and January 28, 2005..

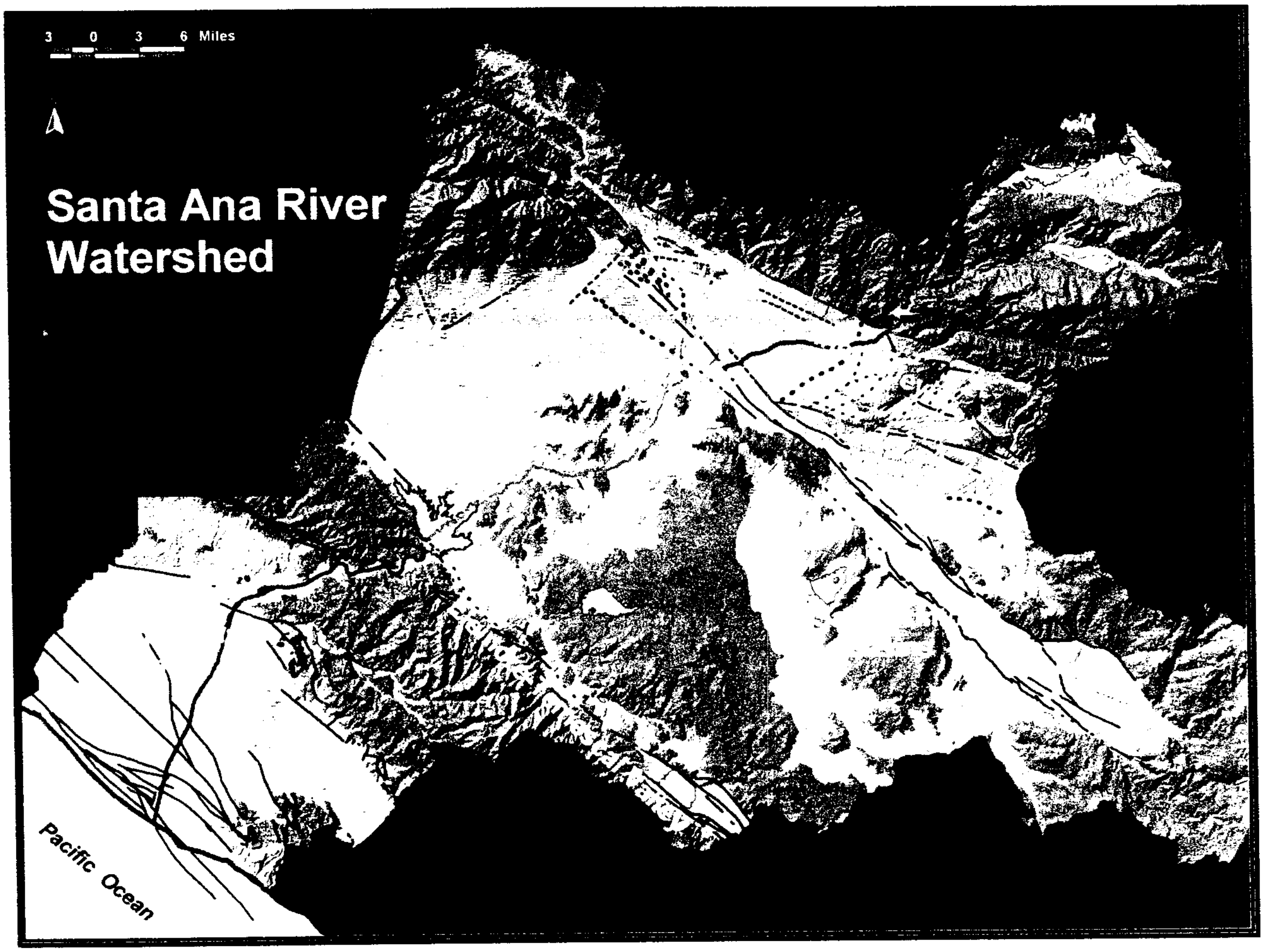
I, Gerard J. Thibeault, Executive Officer, do hereby certify that the foregoing is a full, true and correct copy of a resolution adopted by the California Regional Water Quality Control Board, Santa Ana Region, on April 15, 2005.

Gerard J. Thibeault
Executive Officer

BASIN PLAN AMENDMENT
REQUIRED MONITORING AND ANALYSES

Recomputation of Ambient Water Quality for the Period 1984 to 2003

Final Work Plan



Prepared for

SAWPA Technical Advisory Committee

Prepared by

Wildermuth Environmental, Inc.

February 2004

Basin Plan Amendment
Required Monitoring And Analyses

Recomputation of Ambient Water Quality for the Period 1984 to 2003

Final Work Plan

Prepared for

SAWPA Technical Advisory Committee

Prepared by

Wildermuth Environmental, Inc.

February 2004

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ACRONYM AND ABBREVIATIONS LIST

CBWCD	Chino Basin Water Conservation District
CBWM	Chino Basin Watermaster
CDFM	cumulative departure from the mean
DB	database
DHS	California Department of Health Services
EC	electrolytic conductivity
EDD	electronic data deliverable
EMWD	Eastern Municipal Water District
EPA	US Environmental Protection Agency
EVMWD	Elsinore Valley Municipal Water District
FORTRAN	FORmula TRANslator
GIS	Geographic Information System
IEUA	Inland Empire Utilities Agency
JCSD	Jurupa Community Services District
meq/L	milliequivalents per liter
MS	Microsoft
MSL	mean sea level
OCSD	Orange County Sanitation District
OCWD	Orange County Water District
POTW	Publicly-Owned Treatment Works
QA	quality assurance
QA/QC	quality assurance/quality control
QC	Quality Control
RDBMS	Relational Database Management System
RWQCB	Regional Water Quality Control Board
SAWPA	Santa Ana Watershed Project Authority
SBVMWD	San Bernardino Valley Municipal Water District
SBVWCD	San Bernardino Valley Water Conservation District
STWMA	San Timoteo Watershed Management Authority
TAC	Technical Advisory Committee
TDS	total dissolved solids
TIN	total inorganic nitrogen

ACRONYM AND ABBREVIATIONS LIST

TIN/TDS	total inorganic nitrogen/total dissolved solids
US	United States of America
US EPA	US Environmental Protection Agency
USGS	US Geological Survey
WEI	Wildermuth Environmental Inc
WMWD	Western Municipal Water District
WQ/WL	water quality/water level
YVWD	Yucaipa Valley Water District

1. INTRODUCTION

In 1995, a Task Force was formed to provide oversight, supervision, and approval of a study to evaluate the impact of Total Inorganic Nitrogen (TIN) and Total Dissolved Solids (TDS) on water resources in the Santa Ana Watershed. Members of the TIN/TDS Task Force included:

- Chino Basin Water Conservation District (CBWCD)
- Chino Basin Watermaster
- City of Colton
- City of Corona
- City of Redlands
- City of Rialto
- City of Riverside
- City of San Bernardino
- Eastern Municipal Water District (EMWD)
- Elsinore Valley Municipal Water District (EVMWD)
- Inland Empire Utilities Agency (IEUA)
- Jurupa Community Services District (JCSD)
- Orange County Sanitation District (OCSD)
- Orange County Water District (OCWD)
- Regional Water Quality Control Board, Santa Ana Region (RWQCB) – Advisory Member
- Riverside-Highland Water Company
- San Bernardino Valley Municipal Water District (SBVMWD)
- San Bernardino Valley Water Conservation District (SBVWCD)
- San Timoteo Watershed Management Authority (STWMA)
- Santa Ana Watershed Project Authority (SAWPA) – Advisory Member
- US Geological Survey (USGS) – Advisory Member
- West San Bernardino County Water District
- Yucaipa Valley Water District (YVWD)

Wildermuth Environmental, Inc. (WEI) was retained by the TIN/TDS Task Force, through a contract administered by SAWPA, to conduct Phase 2A of the TIN/TDS Study (Task Order 1998-W020-1616-03). Phase 2A was comprised of the following tasks:

- Task 1: Develop Surface Water Translator for Meeting Groundwater Objectives that Accounts for Nitrogen Losses During Percolation
- Task 2: Develop New Compliance Metric and Monitoring Plan to Replace Current August-Only Below Prado Metric
- Task 3: Develop Updated Boundary Maps for Groundwater Subbasins and New Management Zones

- Task 4: Estimate Regional TDS and Nitrogen Concentrations in Groundwater
- Task 5: Compute TDS and Nitrogen Objectives for New Groundwater Basins and Management Areas

These tasks were completed in July of 2000, and were documented in the TIN/TDS Study – Phase 2A Final Technical Memorandum (WEI, 2000a). The groundwater management zones delineated in this study, with subsequent revisions, were adopted in the January 22, 2004 Basin Plan amendment (see Figures 1-1, 1-2, 1-3b, 1-4 and 1-5), and will replace the groundwater sub-basins of the 1995 Basin Plan.

Table 1-1 and 1-2 display the ambient water quality estimates (for TDS and nitrate) for groundwater management zones that were generated in the Phase 2A study for the periods 1954-1973 and 1978-1997. The ambient water quality estimates from the "historical" period (1954-1973) were used as a basis for the new water quality objectives in the 2004 Basin Plan amendment. The ambient water quality estimates from the "current" period (1978-1997) were used to assess compliance with the new water quality objectives, and to determine the magnitude of assimilative capacity, if it exists, within individual management zones.

If the current quality of a management zone is the same as or poorer than the specified water quality objectives, then that management zone does not have assimilative capacity. If the current quality is better than the specified water quality objectives, then that management zone has assimilative capacity. In the later case, the difference between the objectives and current quality is the amount of assimilative capacity available.

Note in Tables 1-1 and 1-2 that a number of the water quality objectives have been raised to create assimilative capacity and, thus, encourage reclamation and the maximum beneficial use of State waters. These so-called "maximum benefit" water quality objectives for management zones are contingent on the implementation of certain projects and programs by specific dischargers as part of their maximum benefit demonstrations. Also note that the Chino Basin management zones, as delineated in the TIN/TDS Study – Phase 2A Final Technical Memorandum (with revisions), have been revised again to accompany the maximum benefit water quality objectives (see Figure 1-3a).

As part of the agreement to adopt the 2004 Basin Plan amendment, affected parties have agreed to recompute ambient water quality for individual management zones every three years. The determination of current ambient quality shall be accomplished using methodology consistent with that employed by the TIN/TDS Task Force (20-year running averages) to develop the TDS and nitrate water quality objectives included in the 2004 Basin Plan.

Specifically, the 2004 Basin Plan states:

> No later than (*6 months from effective date of this Basin Plan amendment*), Orange County Water District, Irvine Ranch Water District, Inland Empire Utilities Agency, Chino Basin Watermaster, City of Riverside, City of Corona, Elsinore Valley Municipal Water District, Eastern Municipal Water District, City of Colton, City of San Bernardino Municipal Water Department, City of Redlands, Jurupa Community Services District, Western Riverside County Regional Wastewater Authority , Lee Lake Water District, Yucaipa Valley Water District, City of Beaumont, the San Timoteo Watershed Management Authority and the City of Rialto shall submit to the Regional Board for approval, a proposed watershed-wide TDS and nitrogen monitoring program that will provide data necessary to review and update the TDS/nitrogen management plan. Data to be collected and analyzed shall address, at a minimum: (1) determination of current ambient quality in groundwater management zones; (2) determination of compliance with TDS and nitrate-nitrogen objectives for the management zones; (3) evaluation of assimilative capacity findings for groundwater

> management zones; and (4) assessment of the effects of recharge of surface water POTW discharges on the quality of affected groundwater management zones. The determination of current ambient quality shall be accomplished using methodology consistent with that employed by the Nitrogen/TDS Task Force (20-year running averages) to develop the TDS and nitrogen water quality objectives included in this Basin Plan. [Ref. 1] The determination of current ambient groundwater quality throughout the watershed must be reported by July 1, 2005, and, at a minimum, every three years thereafter.

The Basin Plan amendment was adopted on January 22, 2004. The first episode of recomputation of ambient water quality will be for the period 1984-2003 (to be reported by July 1, 2005). This work plan describes in detail the specific tasks involved in the recomputation of ambient water quality for all groundwater management zones listed in Tables 1-1 and 1-2 for the period 1984 to 2003:

Task 1: Meet with Agencies/Develop Unique Protocols

Task 2: Collect Historical Data (1998 to 2003)

Task 3: Process and Upload Historical Data

Task 4: Develop Queries to Extract WQ/WL Data for TDS/Nitrate-N

Task 5: Develop Water Quality Point Statistics for TDS/Nitrate-N

Task 6: Estimate Regional TDS/Nitrate-N in Groundwater

Task 7: Compute Ambient TDS/Nitrate-N for Management Zones

Task 8: Prepare Technical Memorandum

A draft work plan was submitted to the SAWPA Technical Advisory Committee (TAC), the RWQCB, all other affected public agencies, and other interested parties for comment. These comments were addressed, with text revisions, and the comments and responses are included as an appendix to this final work plan.

Table 1-1
Water Quality Objectives for TDS

Groundwater Basin	Management Zone	TDS			
		Water Quality Objective (mg/L)	Historical Ambient[1] (mg/L)	Current Ambient[2] (mg/L)	Assimilative Capacity (mg/L)
San Bernardino Valley & Yucaipa/Beaumont Plains					
	Beaumont -- "max benefit"[3]	330	233	290	40
	Beaumont -- "antideg"	230	233	290	0
	Bunker Hill-A	310	313	350	0
	Bunker Hill-B	330	332	260	70
	Lytle	260	264	240	20
	San Timoteo -- "max benefit"	400	303	300	100
	San Timoteo -- "antideg"	300	303	300	0
	Yucaipa -- "max benefit"	370	319	330	40
	Yucaipa -- "antideg"	320	319	330	0
San Jacinto Basins					
	Canyon	230	234	220	10
	Hemet-South	730	732	1030	0
	Lakeview/Hemet-North	520	519	830	0
	Menifee	1020	1021	3360	0
	Perris-North	570	568	750	0
	Perris-South	1260	1258	3190	0
	San Jacinto-Lower	520	520	730	0
	San Jacinto-Upper	320	321	370	0
Chino, Rialto/Colton, & Riverside Basins					
	Chino-North -- "max benefit"	420	260	300	120
	Chino 1 -- "antideg"	280	280	310	0
	Chino 2 -- "antideg"	250	250	300	0
	Chino 3 -- "antideg"	260	260	280	0
	Chino-East	730	733	760	0
	Chino-South	680	676	720	0
	Colton	410	407	430	0
	Cucamonga -- "max benefit"	380	212	260	120
	Cucamonga -- "antideg"	210	212	260	0
	Rialto	230	230	230	0
	Riverside-A	560	560	440	120
	Riverside-B	290	289	320	0
	Riverside-C	680	684	760	0
	Riverside-D	810	812	?	0
	Riverside-E	720	721	720	0
	Riverside-F	660	665	580	80
	Prado Basin	surface water objective applies	618	819	surface water objective applies
Elsinore/Temescal Valleys					
	Arlington	980	983	?	0
	Bedford	?	?	?	0
	Coldwater	380	381	380	0
	Elsinore	480	476	480	0
	Lee Lake	?	?	?	0
	Temescal	770	771	780	0
	Warm Springs Valley	?	?	?	0
Orange County Basins					
	Irvine	910	908	910	0
	La Habra	?	?	?	0
	Orange County[4]	580	585	560	0
	Santiago	?	?	?	0

? = Not enough data to estimate TDS concentrations; management zone is presumed to have no assimilative capacity. If assimilative capacity is demonstrated by an existing or proposed discharger, that discharge would be regulated accordingly.

[1] Data sampling period was 20 years (1954-1973) for historical ambient water quality computations.

[2] Data sampling period was 20 years (1978-1997) for current ambient water quality computations.

[3] Assimilative capacity created by "maximum benefit" objectives is allocated solely to agency(ies) responsible for "maximum benefit" implementation.

[4] For the purposes of regulating discharges other than those associated with projects implemented within the Orange County Management Zone to facilitate remediation projects and/or to address legacy contamination, no assimilative capacity is assumed to exist.

For detailed description of methodologies employed to calculate ambient water quality refer to Sections 4 & 5 of the Phase 2A Final Technical Memorandum (July, 2000).

This table reflects all revisions requested and approved by the TIN/TDS Task Force since original publication of Table 5-1 in the Phase 2A Final Technical Memorandum (July, 2000).

Table 1-2
Water Quality Objectives for Nitrate-Nitrogen (NO_3-N)

Groundwater Basin	Management Zone	Nitrate-Nitrogen (NO_3-N) Water Quality Objective (mg/L)	Historical Ambient[1] (mg/L)	Current Ambient[2] (mg/L)	Assimilative Capacity (mg/L)
San Bernardino Valley & Yucaipa/Beaumont Plains					
	Beaumont -- "max benefit"[3]	5.0	1.5	2.6	2.4
	Beaumont -- "antideg"	1.5	1.5	2.6	0.0
	Bunker Hill-A	2.7	2.7	4.5	0.0
	Bunker Hill-B	7.3	7.3	5.5	1.8
	Lytle	1.5	1.5	2.8	0.0
	San Timoteo -- "max benefit"	5.0	2.7	2.9	2.1
	San Timoteo -- "antideg"	2.7	2.7	2.9	0.0
	Yucaipa -- "max benefit"	5.0	4.2	5.2	0.0
	Yucaipa -- "antideg"	4.2	4.2	5.2	0.0
San Jacinto Basins					
	Canyon	2.5	2.5	1.6	0.9
	Hemet-South	4.1	4.1	5.2	0.0
	Lakeview/Hemet-North	1.8	1.8	2.7	0.0
	Menifee	2.8	2.8	5.4	0.0
	Perris-North	5.2	5.2	4.7	0.5
	Perris-South	2.5	2.5	4.9	0.0
	San Jacinto-Lower	1.0	1.0	1.9	0.0
	San Jacinto-Upper	1.4	1.4	1.9	0.0
Chino, Rialto/Colton, & Riverside Basins					
	Chino-North -- "max benefit"	5.0	3.7	7.4	0.0
	Chino 1 -- "antideg"	5.0	5.0	8.4	0.0
	Chino 2 -- "antideg"	2.9	2.9	7.2	0.0
	Chino 3 -- "antideg"	3.5	3.5	6.3	0.0
	Chino-East	10.0	13.3	29.1	0.0
	Chino-South	4.2	4.2	8.8	0.0
	Colton	2.7	2.7	2.9	0.0
	Cucamonga -- "max benefit"	5.0	2.4	4.4	0.6
	Cucamonga -- "antideg"	2.4	2.4	4.4	0.0
	Rialto	2.0	2.0	2.7	0.0
	Riverside-A	6.2	6.2	4.4	1.8
	Riverside-B	7.6	7.6	8.0	0.0
	Riverside-C	8.3	8.3	15.5	0.0
	Riverside-D	10.0	19.5	?	0.0
	Riverside-E	10.0	13.3	14.8	0.0
	Riverside-F	9.5	12.1	9.5	0.0
	Prado Basin	surface water objective applies	4.3	22.0	surface water objective applies
Elsinore/Temescal Valleys					
	Arlington	10.0	25.5	?	0.0
	Bedford	?	?	?	0.0
	Coldwater	1.5	1.5	2.6	0.0
	Elsinore	1.0	1.0	2.6	0.0
	Lee Lake	?	?	?	0.0
	Temescal	10.0	11.8	13.2	0.0
	Warm Springs Valley	?	?	?	0.0
Orange County Basins					
	Irvine	5.9	5.9	7.4	0.0
	La Habra	?	?	?	0.0
	Orange County	3.4	3.4	3.4	0.0
	Santiago	?	?	?	0.0

? = Not enough data to estimate nitrate-nitrogen concentrations; management zone is presumed to have no assimilative capacity. If assimilative capacity is demonstrated by an existing or proposed discharger, that discharge would be regulated accordingly.

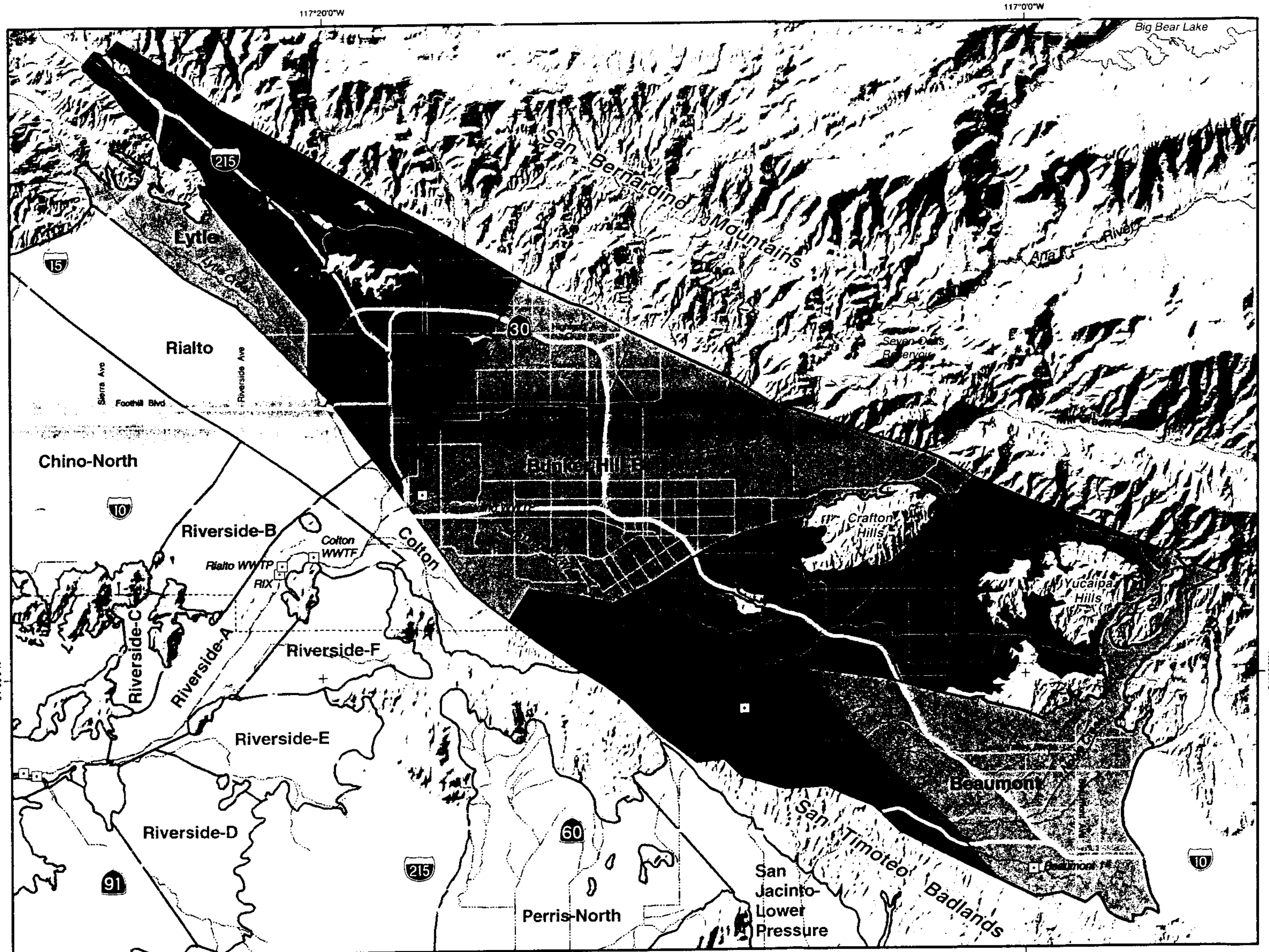
[1] Data sampling period was 20 years (1954-1973) for historical ambient water quality computations.

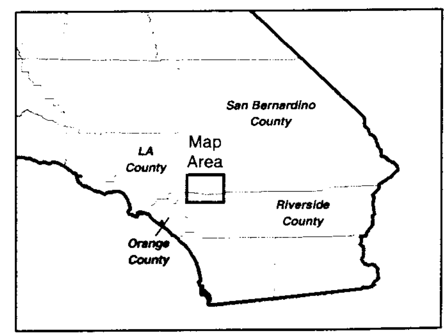
[2] Data sampling period was 20 years (1978-1997) for current ambient water quality computations.

[3] Assimilative capacity created by "maximum benefit" objectives is allocated solely to agency(ies) responsible for "maximum benefit" implementation.

For detailed description of methodologies employed to calculate ambient water quality refer to Sections 4 & 5 of the Phase 2A Final Technical Memorandum (July, 2000).

This table reflects all revisions requested and approved by the TIN/TDS Task Force since original publication of Table 5-1 in the Phase 2A Final Technical Memorandum (July, 2000).





Map Explanation

- Management Zone Boundary
- Rivers & Streams
- Recycled Water Discharge Location

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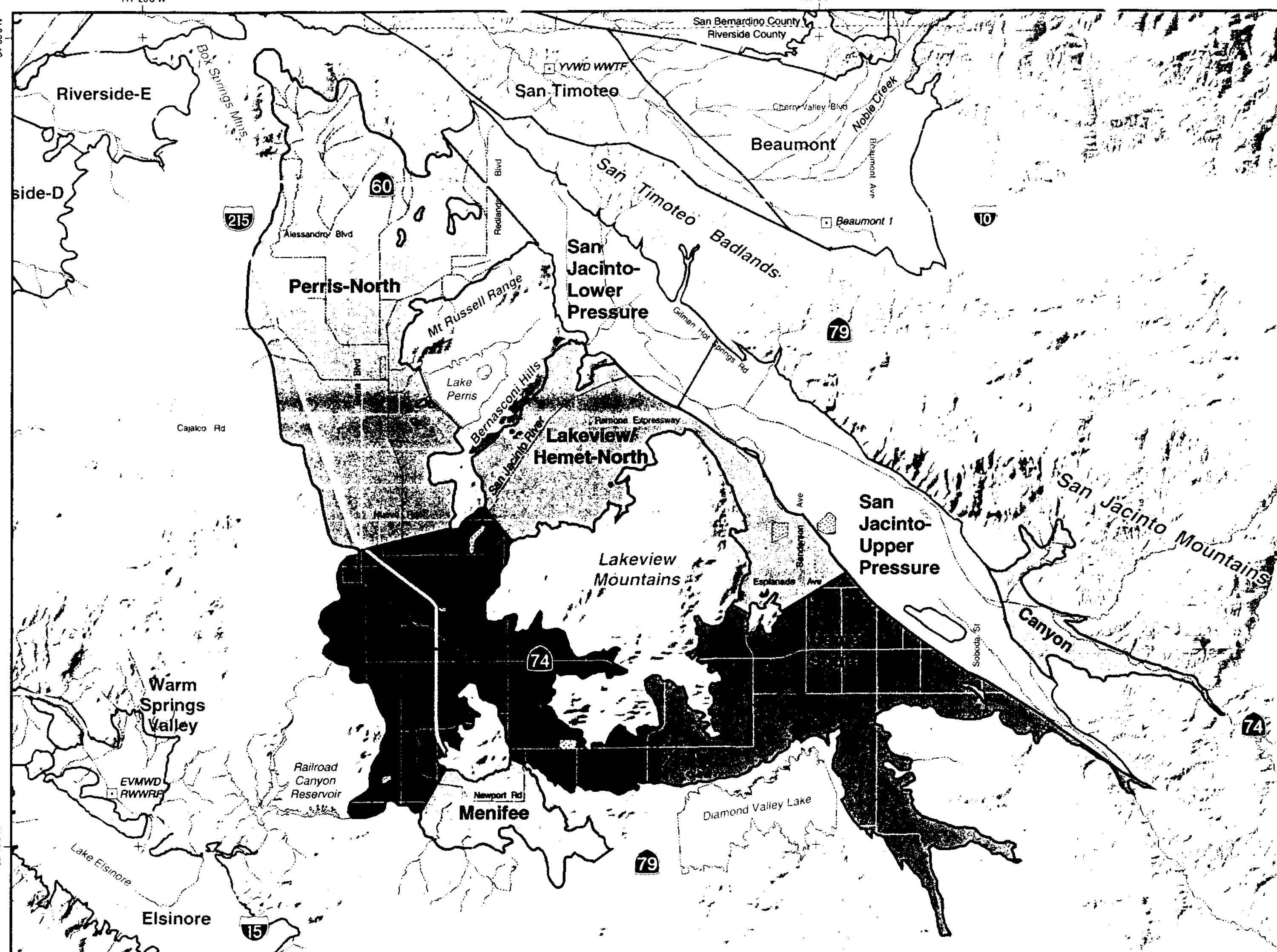
TIN/TDS Task Force
TIN/TDS Study Phase 2A – Task 3
Develop Updated Boundary Maps for Management Zones (as Ammended and Revised)

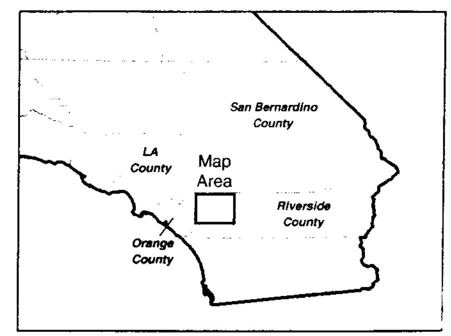
Management Zone Boundaries
San Bernardino Valley & Yucaipa/Beaumont Plains

Figure 1-1



Map Explanation

- Management Zone Boundary
- Rivers & Streams
- Recycled Water Discharge Location
- Recycled Water Pond



0 1 2 3 4 5 6 Miles

0 2 4 6 8 10 KM

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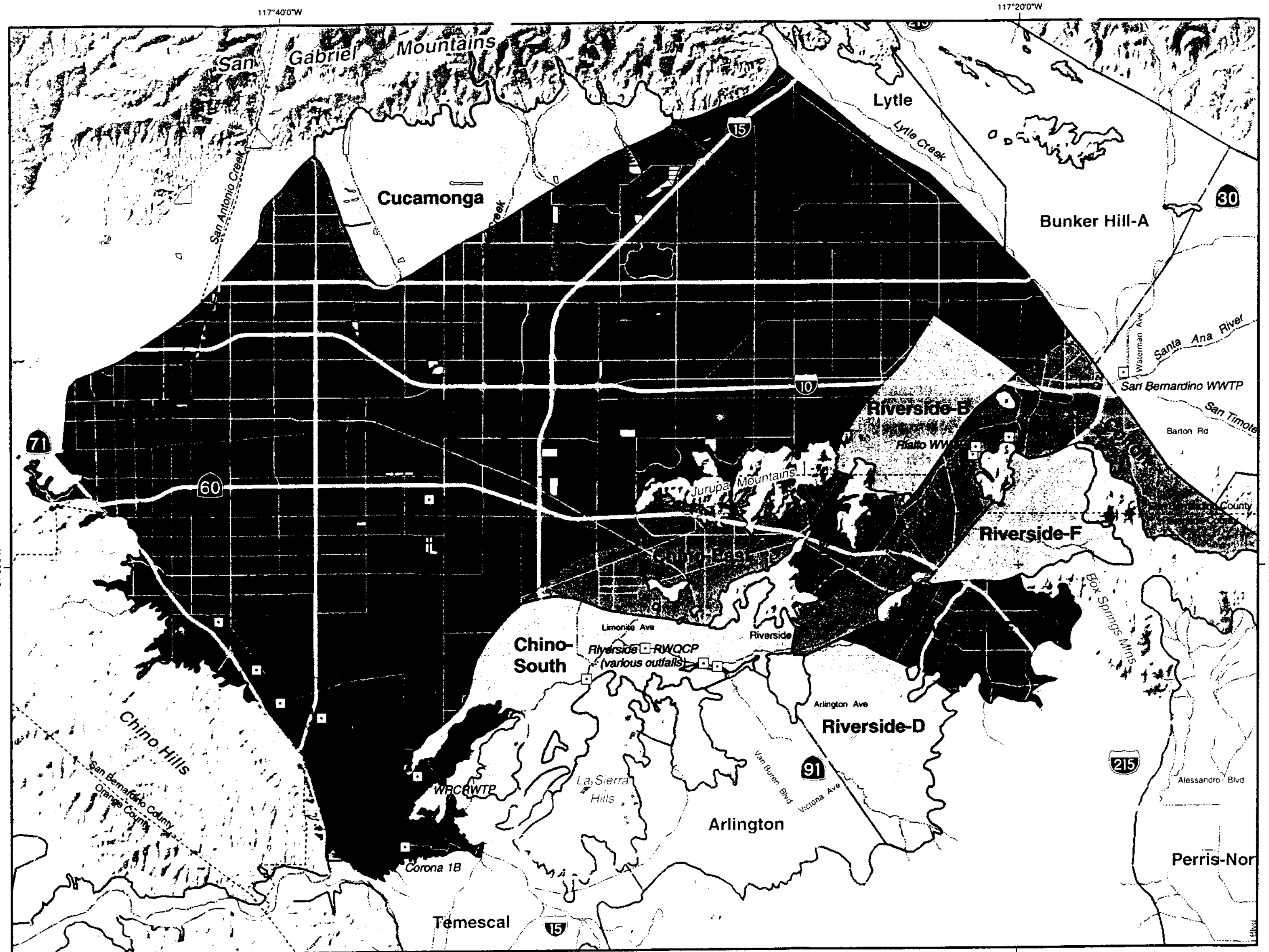
TIN/TDS Task Force

TIN/TDS Study Phase 2A – Task 3
Develop Updated Boundary Maps for Management Zones (as Ammended and Revised)

Management Zone Boundaries
San Jacinto Basins

Figure 1-2

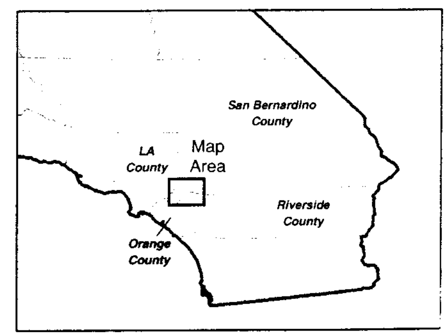


Map Explanation

Management Zone Boundary

Rivers & Streams

Recycled Water Discharge Location



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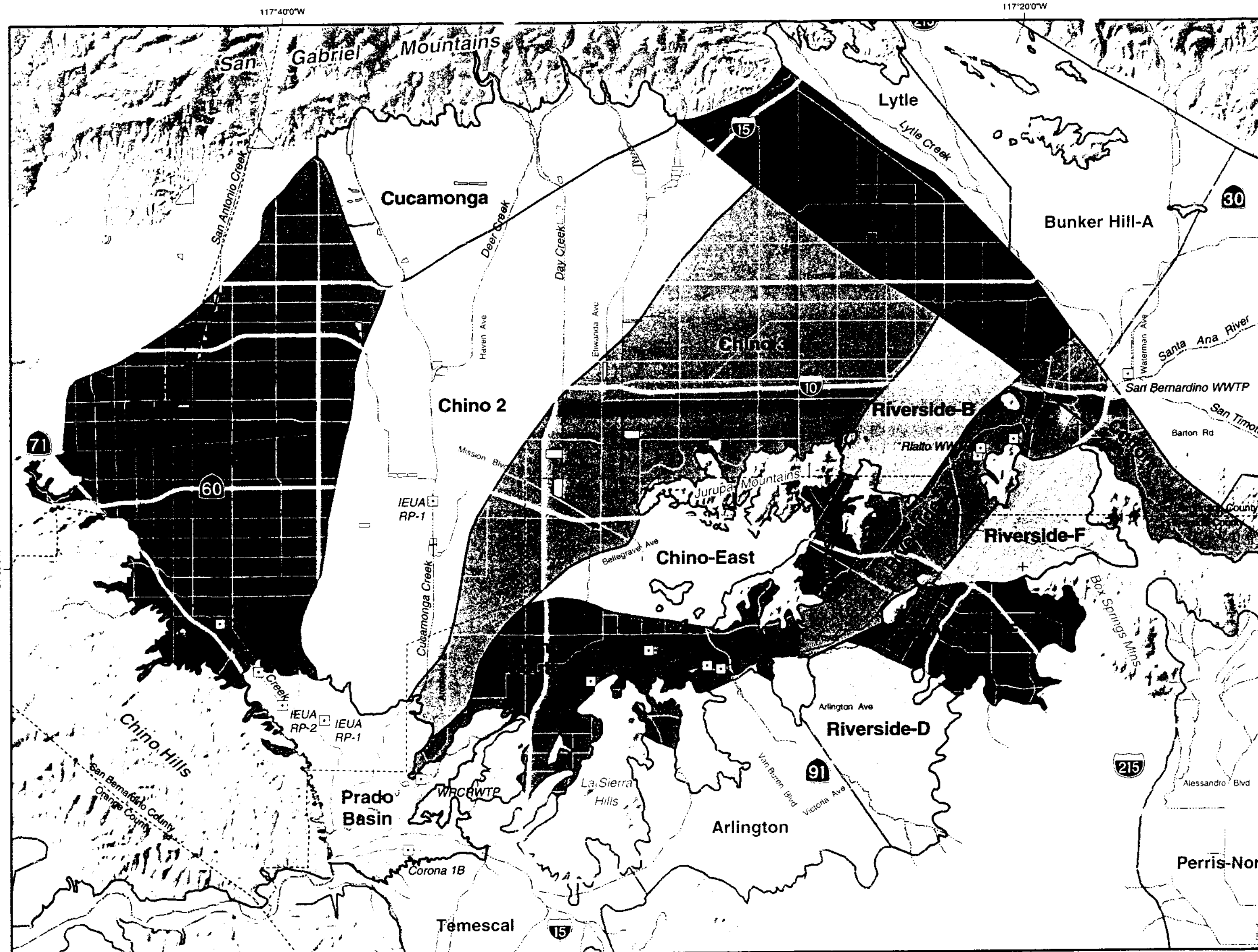
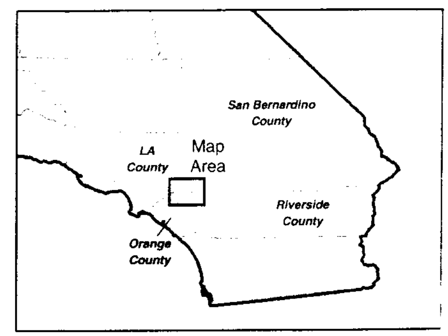
TIN/TDS Task Force

TIN/TDS Study Phase 2A – Task 3
Develop Updated Boundary Maps for Management Zones (as Ammended and Revised)

Management Zone Boundaries
Chino (Maximum Benefit), Rialto-Colton, & Riverside Basins

Figure 1-3a





Map Explanation

Management Zone Boundary

Rivers & Streams

Recycled Water Discharge Location

0 1 2 3 4 5 6 Miles

0 2 4 6 8 10 KM

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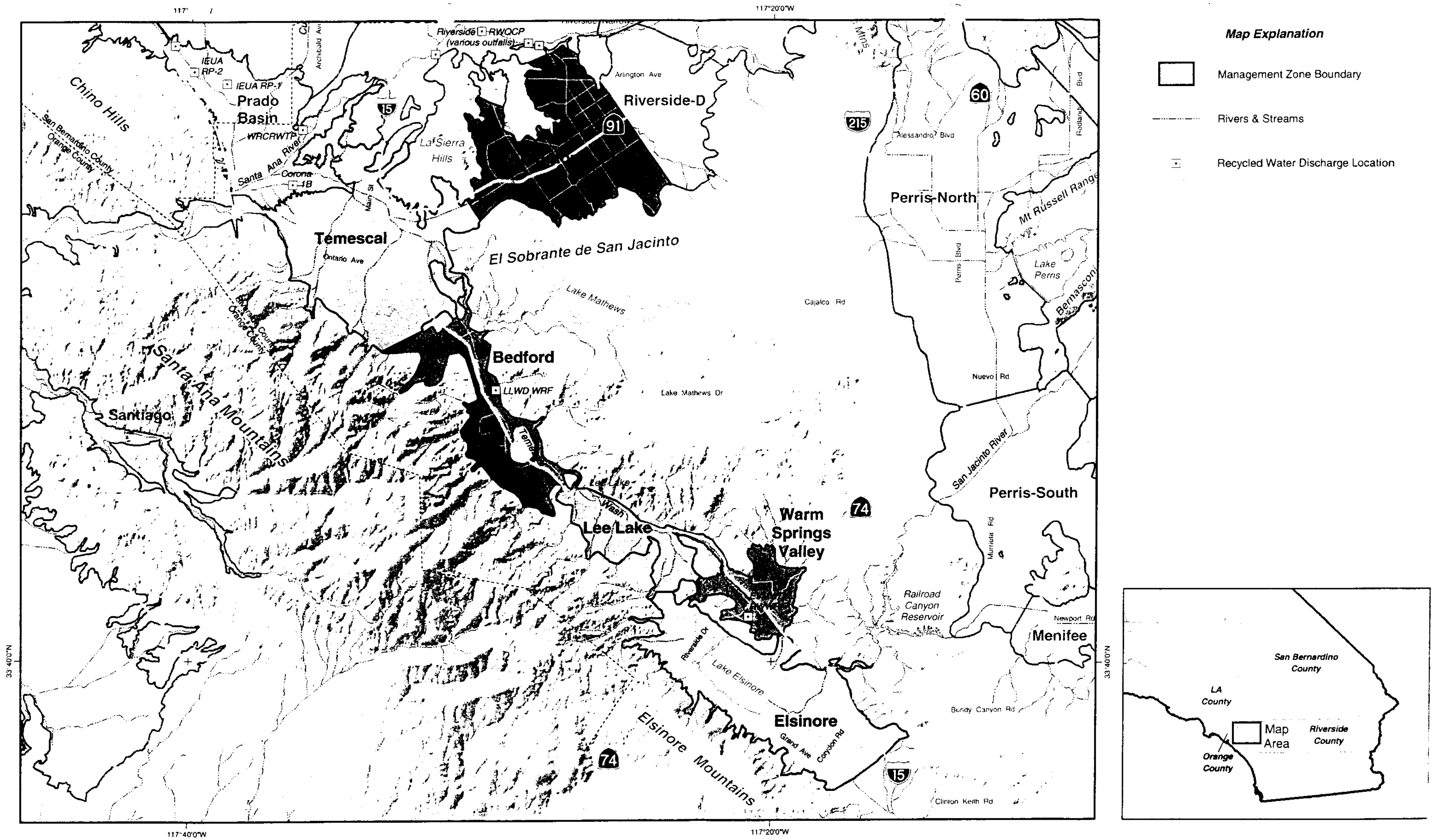
Produced for:

TIN/TDS Task Force

TIN/TDS Study Phase 2A – Task 3
Develop Updated Boundary Maps for Management Zones (as Ammended and Revised)

Management Zone Boundaries
Chino (Anti-degradation), Rialto-Colton, & Riverside Basins

Figure 1-3b



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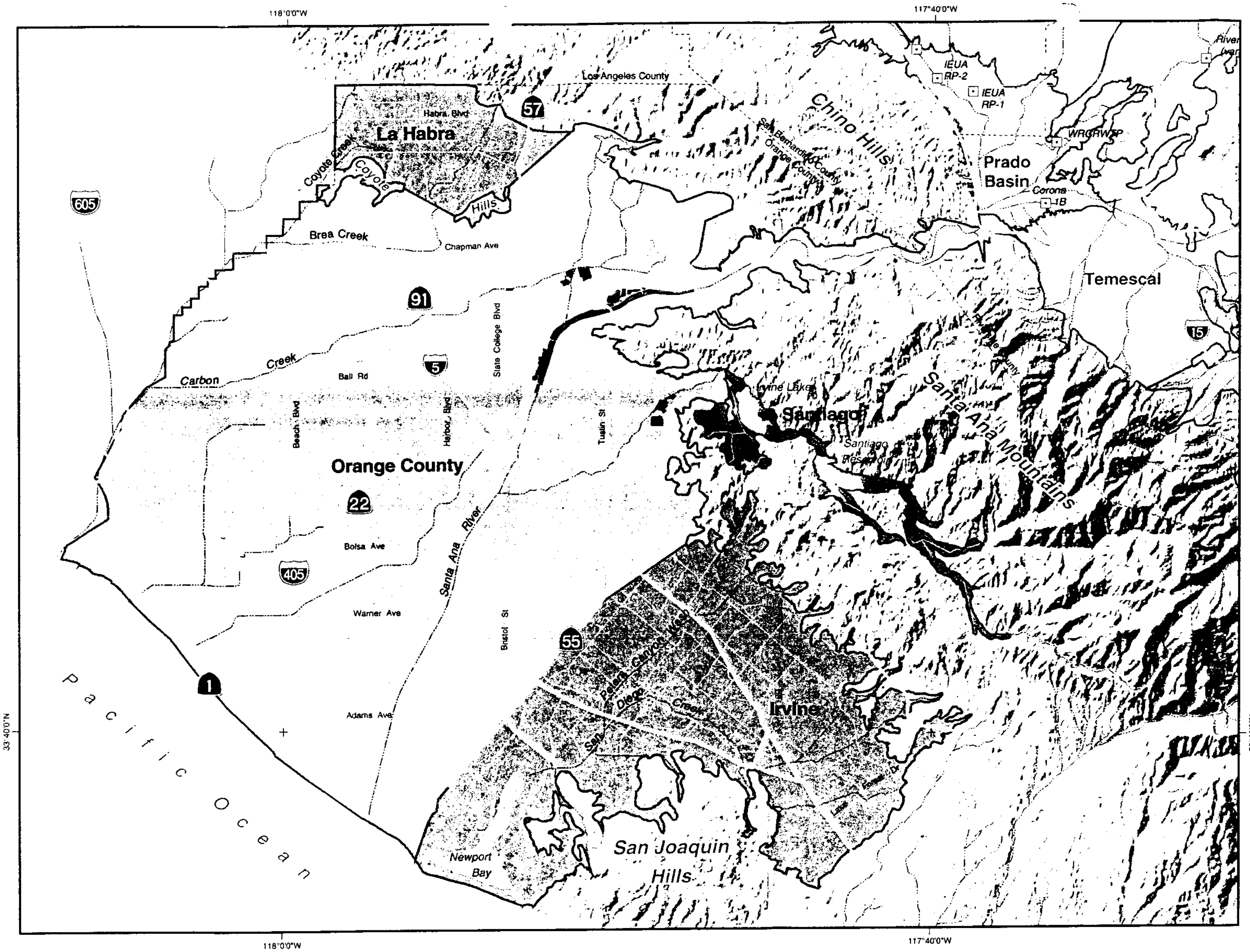
Produced for:

TIN/TDS Task Force

TIN/TDS Study Phase 2A – Task 3
Develop Updated Boundary Maps for Management Zones (as Ammended and Revised)

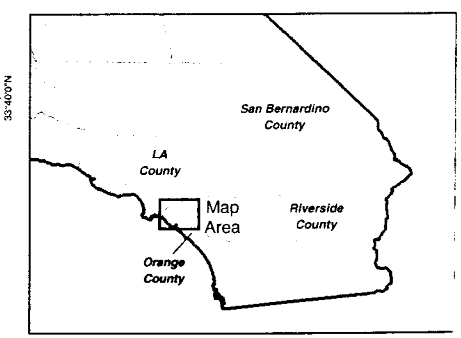
Management Zone Boundaries
Elsinore/Temescal Valleys

Figure 1-4



Map Explanation

- Management Zone Boundary
- Rivers & Streams
- Recycled Water Discharge Location
- Orange County Water District Forebay Recharge Facilities



0 1 2 3 4 5 6 Miles

0 2 4 6 8 10 KM

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TIN/TDS Task Force

TIN/TDS Study Phase 2A – Task 3
Develop Updated Boundary Maps for Management Zones (as Ammended and Revised)

Management Zone Boundaries
Orange County Basins

Figure 1-5

2. Recomputation Of Ambient Water Quality For The Period 1984 To 2003

The most efficient way to process the water quality data to recompute ambient water quality is to load data from 1998 through 2003 into the existing database developed in the Phase 2A study (WEI, 2000b). OCWD and EMWD already have implemented monitoring programs/database management systems. CBWM/IEUA have on-going monitoring programs and also have implemented a fully functional database. SBVMWD is implementing a relational database to support a groundwater model. Historical data (1998 through 2003) can be retrieved electronically from these agencies. Water quality and water level data in the non-Chino Basin portions of WMWD's service area would have to be retrieved from WMWD's sub-agencies or from the State of California, Department of Health Services (DHS) database (Table 2-1).

The following tasks will be necessary to recompute ambient water quality for all management zones listed in Tables 1-1 and 1-2 for the period 1984 to 2003:

Task 1. Meet with Agencies/Develop Specific Protocols

A data set is a collection of data about a specific topic. Data sets are organized in a database in tabular format with columns (called *fields*) and rows (called *records*). Each field contains the same type of information for all records. For example, in a data set of residential addresses, the *fields* would be street number, street name, city, state, and zip code. All the *fields* together form the residential address *record*. However, if only the street number and state *fields* were supplied, then a residential address is meaningless. Because of this, data sets will require a minimum number of *fields* to make a *record* meaningful. This set of *fields* is known as the "Minimum Required Data Fields" (US EPA, 1992).

In Task 1, a checklist of items that will be discussed and resolved with each agency's database (DB) manager or other water quality staff will be developed. This will include, but not be limited to: mapping of the Stations Lookup Table and the Parameter Lookup Table.

For data collection, a water quality data specialist will meet with each data provider to define the electronic data deliverable (EDD) or hard copy data that will be transmitted. It is critical that each agency's DB manager have open and continuous communication with the water quality data specialist. A mutually-defined mapping of data set fields is required so that the mapping of fields is unique and consistent for each data provider and that each data record contains the "minimum required data fields" (Table 2-2). A description of requested data is listed in Table 2-3.

As new or revised information is received, the water quality data specialist will be responsible for updating the STATIONS table and assigning new SAW_IDs (i.e. "Stations Lookup Table"). As new or revised information is received, the water quality data specialist will be responsible for updating the CHEMICALS table and assigning new CHEM_IDs ("Parameter Lookup Table").

Task 2. Collect Historical Data (1998 to 2003)

Water quality data for the Phase 2A TIN/TDS study were only collected through 1997. WEI has downloaded water quality data from the DHS database through May 2002 for the entire watershed (we are currently processing DHS data through May 2003). WEI has used these data for certain portions of the watershed; however, in order to do so, Stations Lookup Tables and Parameter Lookup Tables were developed for these areas. The historical water quality for the remainder of the watershed can be acquired electronically from the four agencies with RDBMSs or the data can be acquired from DHS after the lookup tables in Task 1 are defined.

The water quality data specialist will make follow-up phone calls reminding the agency DB managers of the upcoming request for historical data. Staff level engineers and scientists will meet at the agencies' offices to make hard copies of data that are not available digitally.

Task 3. Process and Upload Historical Data

Once the format of the historical data (hard copy and electronic) is established, tools can be developed to automatically load data into a database as well as generate output data. The tools' main function will be to QA/QC data received with security, data validation, data rejection, and data upload. In addition to the standardized formats, the automatic data loading tools will require a set of rules to follow as data are loaded into the database.

Data collected from agencies that are in hard copy format will be keypunched.

From a quality assurance and quality control (QA/QC) standpoint, centralizing data raises some concerns, including:

- whether enough metadata are included to make the data useful;
- whether data errors are introduced during the data upload; and
- whether data are secure from unauthorized access.

QA/QC will be conducted using various utilities to check and secure data during input and output. For example, valid data entry will be assured by user login, double entry (if necessary), followed by data approval procedures by supervisors/managers. Data manipulation will be logged by placing user and timestamp on every data entry activity that will be recorded in a historical log of each change. Another way of providing QA/QC is defining and using standard formats of data.

Task 4. Develop Queries to Extract WQ/WL Data for TDS/Nitrate-N

Queries will be developed to extract the necessary water quality and water level data to perform the calculations of volume-averaged ambient concentrations.

Task 5. Develop Water Quality Point Statistics for TDS/Nitrate-N

The following steps are proposed to develop water quality point statistics at wells for TDS and nitrate-nitrogen, and are identical to the method used in WEI (2000a):

- *Review TDS and nitrate-nitrogen time histories.* The TDS and nitrate-nitrogen time histories would be developed for all wells used in the estimate of ambient water quality. Each time history would include a cumulative departure from the mean (CDFM) curve for rainfall. The CDFM curve is useful in characterizing the occurrence and magnitude of wet and dry climatic periods. Negatively sloping segments (trending down to the right) in CDFM curves indicate dry periods; and positively sloping segments (trending up to the right) indicate wet periods.

- *Defined data sampling periods.* For historical ambient water quality, the data sampling period was January 1, 1954 to December 31, 1973. For current ambient water quality, the data sampling period is a 20-year period with the latest complete set of data. For the recomputation of current ambient water quality, this period will be January 1, 1984 to December 31, 2003. Current ambient water quality will be computed as a rolling 20-year average.

- *Applied appropriate statistical tests for normality and outliers.* The assumption of the "mean + t*standard error of the mean" approach is that the data are normally distributed or that a transformation can approximate a normal distribution. The use of the Shapiro-Wilk test for both normality and outlier testing was recommended and adopted by the Task Force at the June 15, 1999 meeting. Shapiro and Wilk (1965) developed a test for normality based on normal order statistics. In the Shapiro-Wilk test, a value for the variable, W, is calculated with the formula below. The calculated value of W is then compared with a critical W found in reference tables (*e.g.*, Gibbons, 1994).

$$W = \left(\sum_{i=1}^{n} a_{i,n} \cdot x_i\right)^2 \Bigg/ \sum_{i=1}^{n}\left(X_i - X_{avg}\right)^2$$

where: $a_{i,n}$ = coefficients based on the order of the observation, i, and the number of observations, n. (see for example, Gibbons [1994]).

X_i = i^{th} observation

X_{avg} = mean of n observations

A second series of data quality tests will be conducted based on the results of general mineral analyses, if data are available. These tests are described in *Standard Methods for the Examination of Water and Wastewater* (Greenberg *et al.*, 1992): 1030 F. Checking Correctness of Analyses.

1. Anion-Cation Balance

$$\%\ difference = 100 \cdot \frac{\sum cations - \sum anions}{\sum cations + \sum anions}$$

with the following acceptance criteria:

Anion Sum (milliequivalents per liter [meq/L])	Acceptable % Difference
0 – 3	±0.2 meq/L
3 – 10	±2%
10 - 800	±2-5%

2. Measured TDS = Calculated TDS

$$1.0 < \frac{measured\ TDS}{calculated\ TDS} < 1.2$$

where:

calculated TDS = 0.6 (alkalinity) + Na + K + Ca + Mg + Cl + SO_4 + SiO_3 + NO_3 + F

3. Measured EC and Ion Sums

$$0.9 \cdot EC < 100 \cdot anion\ (or\ cation)\ sum,\ meq/L < 1.1 \cdot EC$$

4. TDS to EC Ratios

$$0.55 < \frac{measured\ TDS}{EC} < 0.7$$

and

$$0.55 < \frac{calculated\ TDS}{EC} < 0.7$$

- If a well has more than one observation of TDS or nitrate-nitrogen per calendar year, the values will be averaged prior to computing the statistics. Only one value per year – the annual average – will be used in the computation of ambient water quality.
- Compute the following statistics for both TDS and nitrate-nitrogen: mean, standard deviation, standard error of the mean, and mean plus t times the standard error of the mean. Mean plus t times the standard error of the mean is the statistic that will be plotted and used to define historical and current ambient water quality.

Task 6. Estimate Regional TDS/Nitrate-N in Groundwater

The following steps are proposed to estimate regional TDS/Nitrate-N in groundwater (WEI, 2000a):

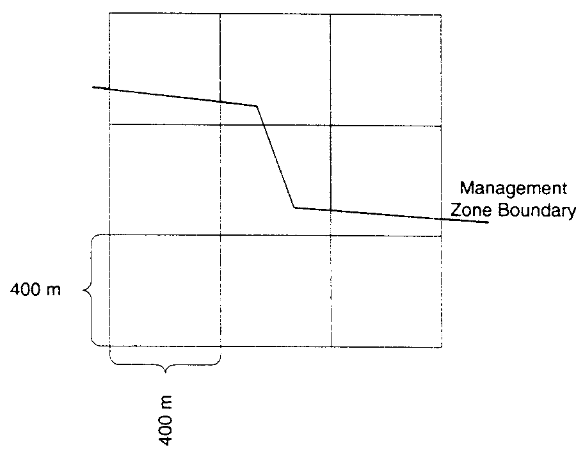
- *For both TDS and nitrate-nitrogen, map the location of wells where statistics have been computed.* These locations will be annotated with the computed statistic. In addition, wells with mean values (but where statistics could not be computed [*e.g.*, less than the required three data points]) will also be plotted. For each management zone, the following maps will be developed:
  - TDS statistic – current ambient (1984 to 2003)
  - Nitrate-nitrogen statistic – current ambient (1984 to 2003)
- For regions with multi-layered aquifers, well construction data will be compared to the hydrostratigraphy developed in the Phase 2A study to identify which aquifers are tributary to each well. The water quality maps listed above will be developed for each aquifer.

- *Develop and digitize contours of TDS and nitrate-nitrogen statistics.* The computed statistics for each period, each aquifer layer (if appropriate), and each water quality constituent will be carefully contoured and digitized, taking into account:
  - management zone boundaries;
  - ancillary water quality data (mean values). These ancillary water quality data will be given less weight when contouring than wells with computed statistics; however, they will be used to help in guiding contours in areas where there is a paucity of computed statistics.

Task 7. Compute Ambient TDS/Nitrate-N for Management Zones

The final steps in the development of ambient water quality determinations will be to develop a rectangular grid coverage over the watershed, estimate the value of the statistic at each grid cell, compute the volume-weighted statistic for each aquifer in each management zone, and then compute the volume weighted statistics for each management zone. If the management zone contains only one aquifer, the last step is not necessary. The specific steps are outlined below:

- *Develop fine rectangular grid.* The grid size will be the same in each management zone and will be fine enough so that the resulting ambient quality determinations will not be significantly influenced by grid size. Numerical tests were done previously (WEI, 2000a) to determine the appropriate grid size. The grid size used in the Phase 2A study was 400x400 meters. This same grid – created using a FORTRAN routine and then imported into ArcInfo – will be used. Where a grid cell is split by a management zone boundary, that grid cell would be assigned parameters based on the apportionment of the grid cell into each management zone (determined by area).



- *Compute volume of groundwater in storage in each grid cell for each time period.* Groundwater elevation contour maps for Fall 2003 will be used to calculate volume of groundwater in grid cells for the current periods. The groundwater elevations for each grid cell will be estimated by an automated gridding program that interpolates between contours. The volume of groundwater in a grid cell for a single-layer aquifer is operationally-defined as:

$$V_i = A_i * (WL_i - B_i) * SY$$

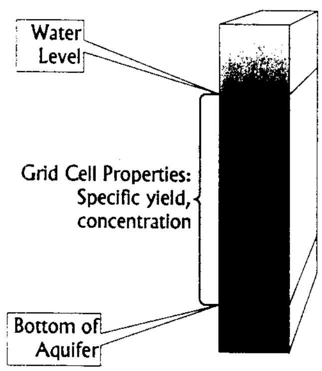
where V_i = volume of groundwater in i^{th} grid cell

A_i = grid cell area (1600 square meters)

WL_i= average elevation of groundwater in i^{th} grid cell (feet above mean sea level [MSL])

B_i = average elevation of the effective base of aquifer in i^{th} grid cell (feet above MSL)

SY = specific yield



GIS coverages of specific yield were previously developed to estimate specific yield at each grid cell. The use of specific yield (as opposed to porosity) causes the computed volume of groundwater to represent the volume that can be pumped, not the actual amount of water in storage.

- *Compute volume of groundwater in storage in each layer of a multi-layer aquifer.* Groundwater in storage for each layer in a multi-layer aquifer will be computed in exactly the same fashion as in a single-layer aquifer. However, the top of a confined aquifer will be used to calculate the water in storage if the groundwater level is above the top of the aquifer. The volume of groundwater in storage in each grid cell will then be summed.
- *Compute volume of groundwater in a management zone.* Total volume of groundwater within a management zone will be calculated by summing the volume of groundwater in all grid cells within the management zone.
- *Estimate value of the water quality statistic for each grid cell.* The value of TDS and nitrate-nitrogen statistic for each grid cell will be estimated by an automated gridding program that interpolates between contours of the statistics.
- *Compute volume-weighted statistic for each aquifer in each management zone.* This water quality statistic will be calculated using the following formula:

$$C_{avg} = \left(\frac{1}{V_T} \right) \cdot \sum C_i \cdot V_i$$

where: C_{avg} is the average concentration in a management zone
V_T is the total volume of groundwater within a management zone
C_i is the concentration in small control volume i
V_i is the volume of water stored in control volume i and with concentration C_i

- *Compute volume-weighted statistic for each management zone.* If the management zone contains only one aquifer, this step is not necessary.

Task 8. Prepare Technical Memorandum

A draft technical memorandum summarizing the results of the recomputation of ambient water quality for the period 1984 to 2003 will be developed. This report will contain pertinent tables, figures, and maps. The draft technical memorandum will be submitted to the SAWPA TAC, the RWQCB, all other affected public agencies, and other interested parties for comment. These comments from all parties will be addressed, with text revisions, and the comments and responses will be included as an appendix to a final technical memorandum.

Table 2-1
Status of Database Development by Agency/Subagency
Groundwater Levels and Groundwater Quality

Agency/Subagency	Status of Database Development: Currently Developed	Developed by Adoption of Basin Plan Amendment	Database Development Unknown
Eastern Municipal Water District	×		
City of Hemet	×		
City of Perris	×		
City of San Jacinto	×		
Lake Hemet Municipal Water District	×		
Nuevo Water Company	×		
Private Wells	×		
San Bernardino Valley Municipal Water District		×	
Bloomington		×	
Colton		×	
Grand Terrace		×	
Highland		×	
Loma Linda		×	
Redlands		×	
Rialto		×	
San Bernardino		×	
Yucaipa		×	
Western Municipal Water District			×
Box Springs Mutual Water Company			×
City of Corona			×
City of Norco			×
City of Riverside			×
Eagle Valley Mutual Water Company			×
Elsinore Valley Municipal Water District			×
Jurupa Community Services District	×		
Lee Lake Water District			×
Rancho California Water District			×
Riverside Highland Water Company			×
Santa Ana River Water Company	×		
Inland Empire Utilities Agency	×		
Chino Desalter Authority	×		
Chino Institute for Men	×		
City of Chino	×		
City of Chino Hills	×		
City of Ontario	×		
City of Upland	×		
Cucamonga County Water District	×		
Fontana Water Company	×		
Monte Vista Water District	×		
Private Wells	×		
San Antonio Water Company	×		
Orange County Water District	×		
City of Anaheim	×		
City of Buena Park	×		
City of Fountain Valley	×		
City of Fullerton	×		
City of Garden Grove	×		
City of Huntington Beach	×		
City of La Palma	×		
City of Newport Beach Water Department	×		
City of Orange	×		
City of Santa Ana Municipal Services	×		
City of Seal Beach	×		
City of Tustin, 235 E. Main Street	×		
City of Westminster	×		
East Orange County Water District	×		
Irvine Ranch Water District	×		
Mesa Consolidated Water District	×		
Orange Park Acres Mutual Water District	×		
Santiago County Water District	×		
Serrano Water District	×		
Southern California Water Company	×		
Yorba Linda Water District	×		
Private Wells	×		

Table 2-2
Minimum Required Data Fields

Table: Stations

Field	Description
Station Name	Unique station name
Station Identifier	Unique station identifier
Agency	Agency or source of information
Owner	Owner name of the station
Station Type	Type of station
Physical Description	Physical description of the station
X,Y Location	Coordinate location of the station
Location Units of Measure	Units of location coordinates
Location Datum	Datum of location coordinates
Location Projection	Projection used for location coordinates
Ground Surface Elevation (wells only)	Value of ground surface elevation (GSE)
GS Elevation Method (wells only)	Method used to measure GSE
GS Elevation Units (wells only)	Units of GSE
GS Elevation Datum (wells only)	Datum of GSE
GS Elevation Measure Date (wells only)	Date GSE measured
Ground Surface to Reference Point (wells only)	Distance from GSE to reference point
Reference Point Description (wells only)	Description related to RPE
Perforated Interval (wells only)	"From" and "To" fields (depth in feet-bgs)

Table: Groundwater Elevations

Field	Description
Station Identifier	Unique station identifier
Agency	Agency or source of information
Date Measured	Date measurement taken
Time Measured	Time measurement taken
Well Activity	Activity of the station at time of measurement
Well Activity Comments	Activity comments related to measurement
Reference Point Description	Description related to RPD
Reference Point to Ground Water Level	Distance from RPE to groundwater level
Qualifier	Value qualifier
Units of Measure	Units of groundwater level elevation

Table: Analysis

Field	Description
Station Identifier	Unique station identifier
Date Sampled	Date sample taken
Time Sampled	Time sample taken
Chemical Name or Code	Name or code of constituent analyzed
Qualifier	Value qualifier for result
Result	Concentration or value of analysis
Units of Measure	Units of constituent concentration

Table 2-3
Description of Requested Data

Station Data	Verify (1)	Obtain (2)
Owner	✔	✔
State Well Number	✔	✔
Recordation Number	✔	✔
DHS Identifier	✔	✔
Database Agency Identifier		
Local Well Name	✔	✔
Location (description and lat-long or UTM coor., if avail.)	✔	✔
Well Construction Log	✔	✔
Lithologic Log	✔	✔
Ground Surface Elevation	✔	✔
Reference Point Elevation	✔	✔
Groundwater Level Data		
Date and Time		✔
Depth to Water		✔
Measuring Entity		✔
Qualifiers, if any (e.g. static, 24-hour static, pumping well, dynamic level, etc.)		✔
Water Quality Parameters		
Date and Time		✔
Sampling Entity		✔
Calcium		✔
Magnesium		✔
Sodium		✔
Potassium		✔
Manganese		✔
Iron		✔
Bicarbonate		✔
Carbonate		✔
Sulfate		✔
Chloride		✔
Boron		✔
Fluoride		✔
Orthophosphate		✔
Ammonia as NH3 or N		✔
Ammonium as NH4 or N		✔
Nitrate as NO3 or N		✔
Nitrite as NO2 or N		✔
Total Phosphorus		✔
Total Organic Carbon		✔
Total Hardness as CaCO3		✔
Total Alkalinity as CaCO3		✔
Electrical Conductivity		✔
Total Dissolved Solid		✔
pH		✔
Laboratory Name		✔
Analysis Methods		✔
Detection Limits		✔

(1) - verify that existing data in TIN/TDS database is correct
(2) - obtain post-1997 data to update TIN/TDS database

3. References

Gibbons, R. D. 1994. Statistical Methods for Groundwater Monitoring. John Wiley & Sons. New York.

Greenberg, A. E., L. S. Clesceri, and A. D. Eaton. 1992. Standard Methods for the Examination of Water and Wastewater. 18th Edition. American Public Health Association/American Water Works Association/Water Environment Federation.

Shapiro, S.S., and M.B. Wilk. 1965. An Analysis of Variance Test for Normality (Complete Samples). Biometrika 52:591-611.

US EPA. 1992. Definitions for the Minimum Set of Data Elements for Ground Water Quality. Office of Water (WH55OG)EPA 813/B-92-002. July 1992.

Wildermuth Environmental, Inc. 2000a. TIN/TDS Phase 2A: Tasks 1 through 5. TIN/TDS Study of the Santa Ana Watershed. Technical Memorandum. July 2000.

Wildermuth Environmental, Inc. 2000b. TIN/TDS Phase 2A: MS Access Database for TIN/TDS Study of the Santa Ana Watershed. Technical Memorandum. July 2000. Appendix A

1. EMWD Comments and Responses

Comment Number	Reference	Comment	Response
1	Page 2-2	*Task 5* - "The TDS and nitrogen time histories would be developed...Each time history would include a cumulative departure from the mean (CDFM)...useful in characterizing the occurrence and magnitude of wet and dry climatic periods." My guess is the CDFM is for rainfall and not TDS and nitrogen time histories and probably should not be mentioned as part of TDS and nitrogen time histories task. But, if the CDFM is for TDS and can be used for characterizing the magnitude of wet and dry climatic periods, I would like to learn how you do that.	CDFM is for rainfall; and the document was modified to clarify this point.
2	Page 2-5	*Top of the page before Task 7* - "ancillary water quality data will be given less weight when contouring..." It is not clear what is the criteria used for setting these ancillary water quality data. Please provide a description on the criteria used for setting these ancillary water quality data.	When three or more data points were available for a given well, the mean plus standard error of the mean was contoured. When one or two data points were available, the average was used as a guide to contouring.
3	Page 2-6	*Effective base of aquifer* - Are you using EMWD's base elevation contours for the effective base of aquifer? Also, what is the criteria for the effective base of aquifer that you use when you don't have the base contours?	The same effective base of the aquifer will be used as in the Final Phase 2A report. Some of these data were provided by EMWD.
4	Page 2-6	*Specific Yield* - It seems like you are not going to re-calculate SY using new wells data. It makes sense not to re-calculate this value. I agree with this, since you are trying to calculate the ambient water quality solely for the purpose of comparing it to the Management Zone Objectives (that you have already calculated) and we should try to generate a number which uses the same geographic information base as the Management Zone Objectives. Having said this, I think it also makes sense not to use data from areas that did not have information during the historical ambient quality (Management Zone Objectives) calculations. My concern is how to deal with the Desalter wells? The Management Zone	This is a policy issue. OCWD made a similar comment on the Phase 2A report (see comment on Page 2-3 of Appendix B): "Further in-depth analyses (for example, comparisons of historical versus current ambient water quality at individual wells) may indeed provide interesting information, but these discussions were not part of the original scope of work." This issue will need to be resolved by the SAWPA TAC prior to recomputing of ambient water quality.

		Objectives were calculated without any geographic information from these high TDS areas, as a result the water quality in the desalter well areas were interpolated when you calculated the Objectives. If we use the water quality data from these desalter wells in calculating the current ambient water quality, we may get values that are not comparable with the Management Zone Objectives, and may show phantom basin degradations that are not true. Would you please tell me how you are planning to deal with the Desalter well data?	
5	Table 2-1	Please delete "City of Moreno Valley" from this table. The City of Moreno Valley does not own any wells.	Comment noted and the table was modified.

2. SAWPA Comments and Responses

Comment Number	Reference	Comment	Response
1	Page iv acronyms/abrv	This table appears to be a generic table of acronyms that does not specifically apply to this report. Not sure it has any value. Either tailor the list to this report (and remove acronyms/abbreviations from the body of the report) or delete this list.	Comment noted and the table has been modified.
2	Page 1-1 Paragraph 1	Remove bullet for MWDSC. They were not a member of the Task Force.	Comment noted and the text has been modified.
3	Page 1-1 Paragraph 1	Please add "San Timoteo Watershed Management Authority" (STWMA)	Comment noted and the text has been modified.
4	Page 1-2 Last paragraph	The Basin Plan requirements state that determinations shall be accomplished using a methodology consistent with that employed by the TIN/TDS Task Force. This report should definitively state somewhere in the document that the proposed methodology does or does not meet this requirement. It should further state specifically any variations from the previous method (if any).	Comment noted and the text has been modified.
5	Page 1-3 Last paragraph	Comments should also be addressed by making all appropriate changes to the body of the text. The current text states that this will occur, but it is not clear.	Comment noted and text change to state, "Comments from all parties will be addressed in a final work plan, with text revisions and the comments and responses included as an appendix to the work plan."
6	Page 2-1 Paragraph 1	There may be useful data available from WMWD in a more comprehensive format that going to all of the sub agencies. WMWD has a "Cooperative Well Program" that generates data tables on biannual basis. SAWPA uploads these data to our GIS. It may or may not be a better source of data.	Comment noted.
7	Page 2-2	Also state that QA/QC processes will be specified and	Comment noted. QA/QC processes will be specified in the

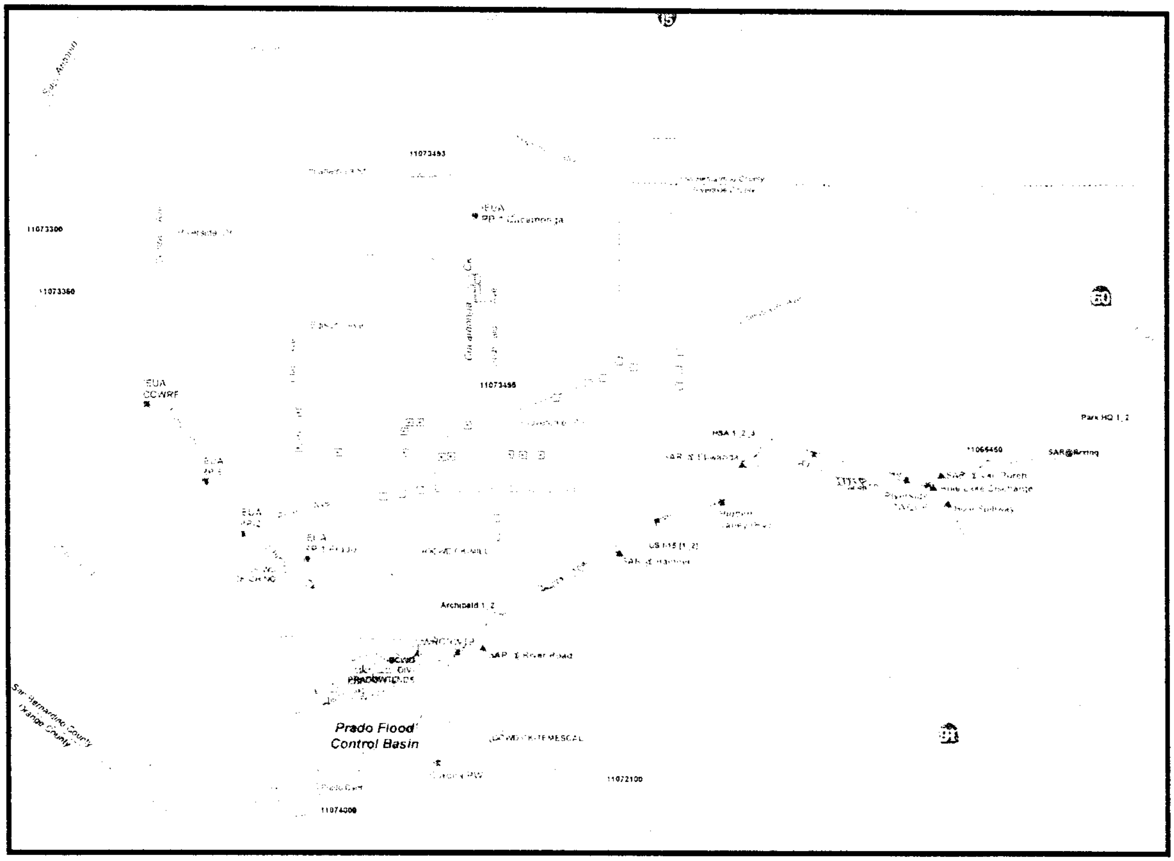
	Task 3 QA/QC	described in detail (and routines provided) in final documentation.	final report and routines will be provided.
8	Page 2-2 Task 4	Is this where the subset(s) of wells to be used in the analysis are determined? If so, discuss. If not, discuss under the appropriate task. How is the selection made? What are the criteria? Is this process and are the set of wells different than previous computations? If so, how? What are the implications?	The procedure to be used is that defined in the basin plan amendment and described in Section 4 of the Final Phase 2A report.
9	Page 2-4 Bullet after Step 4	Is this a statistically valid approach? The process can then involve calculating a mean of a set of averages. Is this the best way?	This method was developed by the Task Force and the consultants and was adopted by the January 22, 2004 Basin Plan Amendment.
10	Page 2-4 Task 6	Well locations- Suggest this task also include a step to compare locations of wells for this computation to wells for previous computations. This would provide for at least a qualitative (if not quantitative) analysis/ discussion of any variations from one computation to the next.	See response to EMWD Comment 4.
11	Page 2-4 Last bullet	Final report should document where this occurs.	Comment noted.
12	Page 2-5 First bullet	How is the contour development process done? Manually or with computer software? Which software (some do better jobs than others)? Or is it a combined method? Is there a QC process?	Contouring is done manually. RWQCB staff and other stakeholders are invited to review and comment on the contouring.
13	Page 2-5 Task 7, first paragraph	Provide outputs of all of these processes (GIS coverages, etc.) in final documentation/delivery.	Comment noted; these will be provided in the final report.
14	Page 2-5 Grid development	Is a unique grid developed for each Management Zone that optimizes the origin (best fit) for that MZ or is there one grid for the entire watershed (same grid origin for all Management Zones)? What are the benefits/drawbacks of each method?	There is one grid for the entire watershed. There would be no discernable computational differences. The cells are divided at management zone boundaries (see page 5-1).

15	Page 2-5 Last bullet	If understood correctly, the same volume is assumed for all 20 years, and therefore there is no consideration of drawdown or recharge over time. Has this simplifying assumption been considered as to how it impacts the results?	The development of volume-weighting approach was discussed in detail by the Task Force and Consultants and the decision to use the end-of period volume was established by consensus. The volume is not assumed constant for the 20-year period. It simply is used to weight the water quality statistics.
16	Page 2-6 Last bullet	Is the "volume weighted statistic for each aquifer in each management zone" the same as the "ambient value" shown in Tables 1-1 and 1-2? If so, please state it. If not, how does this statistic get used to generate the ambient value?	No, this statistic is for each aquifer in each management zone. The next bullet describes combining these statistics for the management zone.
17	Page 2-7 Task 8	Please expand the description of what is contained in the technical memorandum to reflect reporting requirements defined in the Basin Plan Amendment in more detail (1) determination of current ambient quality in groundwater management zones; (2) determination of compliance with TDS and nitrate-nitrogen objectives for the management zones; (3) evaluation of assimilative capacity findings for groundwater management zones; and (4) assessment of the effects of recharge of surface water POTW discharges on the quality of affected groundwater management zones. Include text to ensure that the Technical Memorandum also details specifics of the process (e.g., which wells were selected, interim calculations, GIS coverages, databases, and other electronic products, etc.) to make sure that the calculations and the process are fully documented.	The information developed in this process will be presented in the same format as the Final Phase 2A report and consistent with the Basin Plan Amendment. These data will be provided to the RWQCB. The RWQCB will: (1) determine current ambient quality in groundwater management zones; (2) determine compliance with TDS and nitrate-nitrogen objectives for the management zones; (3) evaluate assimilative capacity findings for groundwater management zones; and (4) assess the effects of recharge of surface water POTW discharges on the quality of affected groundwater management zones. The final text will fully document the details of the process.

Santa Ana Watershed
Basin Monitoring Program

Demonstration of Nitrogen Loss in Reach 3 of the Santa Ana River

Draft Work Plan



Prepared for
Basin Monitoring Program Task Force

Prepared by
Wildermuth Environmental, Inc.

June 2004

Santa Ana Watershed
BASIN MONITORING PROGRAM

Demonstration of Nitrogen Loss in Reach 3 of the Santa Ana River

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Prepared for

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June 2004

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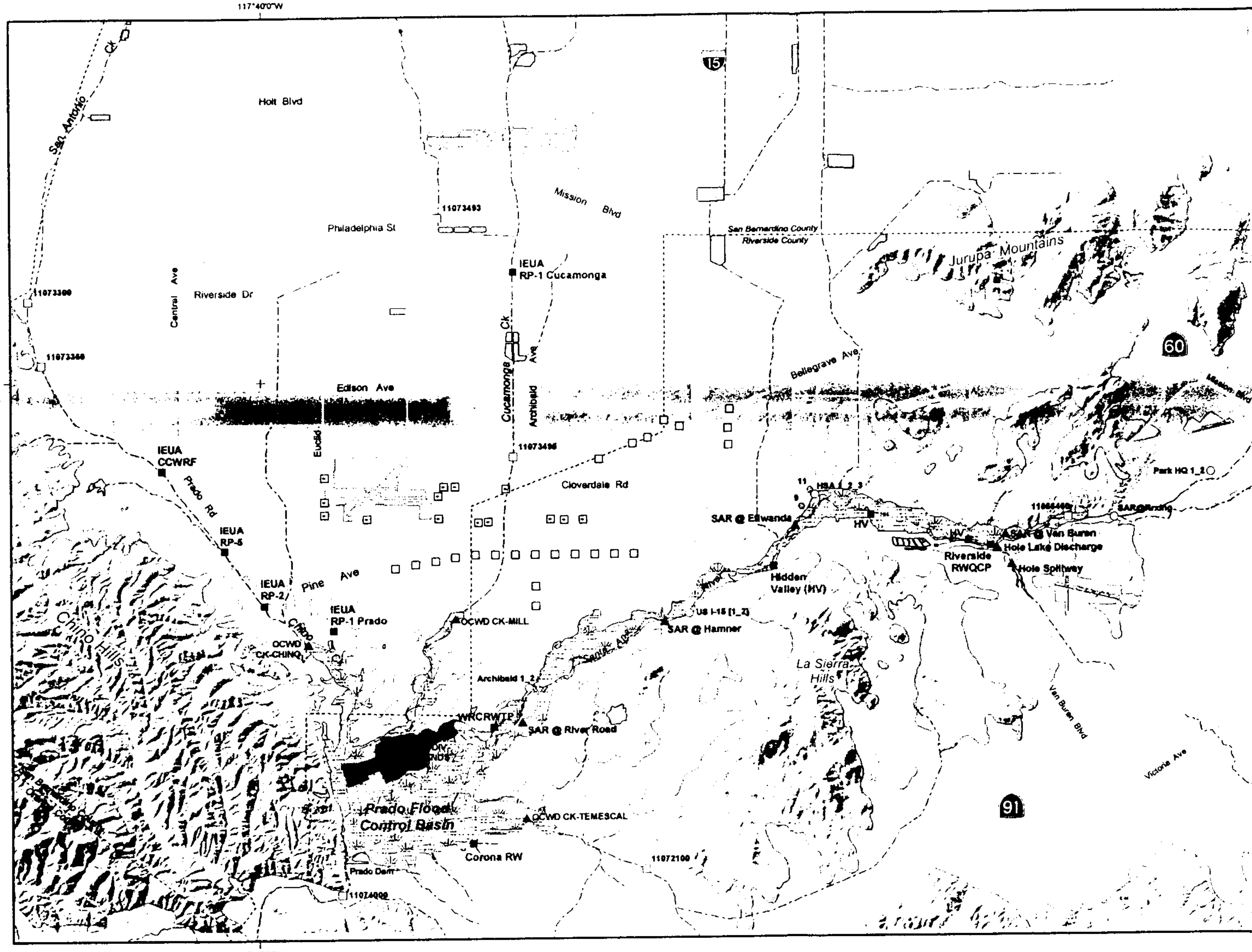
ACRONYM AND ABBREVIATIONS LIST

ASTM	American Society for Testing and Materials
CA	California
CD	compact disk
CDA	Chino Desalter Authority
CoC	Chain of Custody
COPC	Constituents of Potential Concern
DHS	California Department of Health Services
DOT	Department of Transportation
DTSC	Department of Toxic Substances Control
DWR	California Department of Water Resources
EC	Electrolytic Conductivity
EPA	US Environmental Protection Agency
FOT	Fields of Testing
FTP	File Transfer Protocol
GIS	Geographic Information System
gpm	gallons per minute
GPS	Global Positioning System
HCMP	Hydraulic Control Monitoring Program
HCO_3	bicarbonate ion
IEUA	Inland Empire Utilities Agency
LIMS	Laboratory Information Management System
MBAS	Methylene-Blue Active Substances
MCL	maximum contaminant level
MDL	Method Detection Limits
mg/L	milligrams per liter
mL	milliliter
MRL	Minimum Reporting Levels
MS	Microsoft
MS	Microsoft
MZ	Management Zone
NAWQA	National Water Quality Assessment



Main Map Features

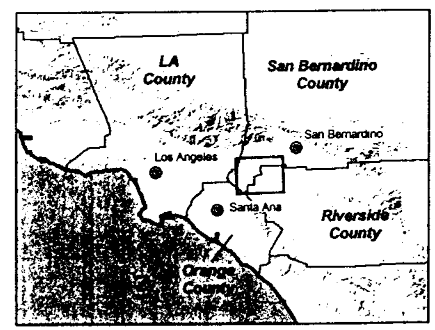
- Ad Hoc Surface Water Station – HCMP
- USGS Gaging Stations
- USGS SAR-NAQWA Wells
- Santa Ana River Water Company Wells
- Recycled Water Discharge Locations
- Ad Hoc Surface Water Station – OCWD
- Existing Desalter-1 Well
- Future Desalter Well (planned location)

Other Features

- Flood Control and/or Conservation Basin
- OCWD Duck Ponds
- SAR Phreatophytes

Geology

- Unconsolidated Sediments
- Consolidated Bedrock



0 1 2 3 4 Miles

0 2 4 6 KM

Produced by:

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File: Figure_2-1.mxd

Basin Monitoring Program Task Force

Location of Surface Water Stations and Groundwater Wells Used in N-Loss Studies

Figure 2-1

3. FIELD SAMPLING PROGRAM

The intent of groundwater and surface water monitoring is to evaluate the state of nitrogen loss in Reach 3 of the Santa Ana River (Figure 3-1). The nitrogen loss coefficient is defined as the percentage of total nitrogen reduction from average concentrations in the Santa Ana River to underlying groundwater that is primarily comprised of recharging river water (Section 4). The demonstration that the groundwater sampled in the study wells is significantly influenced by recharging groundwater will be made by using water chemistry tools – such as Piper Diagrams, Stiff Diagrams, and/or Water Character Index – at selected locations. Samples to be used in this analysis will be collected during sampling events at a regular frequency at key locations along the Santa Ana River, as described in the monitoring program outlined in this section

3.1 Collect Groundwater Samples

The groundwater quality wells will be sampled every three weeks for the first 4 months of the project, followed by monthly sampling for the duration of the study. The first three rounds of samples were collected as part of the Hydraulic Control Monitoring Program (WEI, 2004) utilizing the methodologies and protocols outlined herein. The remaining 12 months of this work plan will be conducted by the Task Force.

The field activities for this project will generally be in accordance with the guidelines established in California EPA (1994) and US EPA (1998). These protocols will be followed to ensure the collection of high-quality and well-documented data. This subsection includes the following:

- pre-sampling activities;
- sample collection;
- sample labeling and handling; and
- sample documentation and tracking.

3.1.1 Pre-Sampling Activities

Pre-sampling activities include static water level measurements, well purging, and frequency of sampling.

Water Level Measurement. The depth to water will be measured in each well casing using an electric water level sounder to the nearest 0.01 foot. The depth to static water level will be measured by lowering the probe into the well and obtaining two successive readings that agree to within 0.01 feet. Measurements will be referenced to the north side or to a surveyed reference mark at the top of the well casing.

USGS NAWQA and SARWC Monitoring Well-11 Purging. These wells will be purged and sampled utilizing low-flow techniques in accordance with ASTM D 6771-02 and EPA/540/S-95504. These wells are located adjacent to the losing reach(es) of the Santa Ana River, where nitrate is expected to enter via and be limited to the uppermost saturated strata underlying the immediate vicinity. The low-flow technique allows the sampling of the uppermost stratum by reducing the amount of mixing of groundwater originating from deeper saturated strata that normally occurs when standard higher-flow techniques are followed. Thus, nitrogen losses that may be attributed to soil/aquifer media can be accurately evaluated without bias caused by dilution from deeper saturated strata.

Low-flow sampling involves purging groundwater at a diminished rate such that aquifer stress is minimized via reduced pore velocities below 3 cm/s. The reduced pore velocity maintains the proper in-

ACRONYM AND ABBREVIATIONS LIST

ND	not detected
NELAC	National Environmental Laboratory Accreditation Conference
NELAP	National Environmental Laboratory Accreditation Program
NH_3	ammonia
NO_2	nitrite
NO_3	nitrate
OBMP	Optimum Basin Management Program
OCWD	Orange County Water District
POTW	Publicly-Owned Treatment Works
QA	quality assurance
QA/QC	quality assurance/quality control
QC	quality control
RWQCB	Regional Water Quality Control Board
SARWC	Santa Ana River Water Company
SO_4	sulfate ion
SWQIS	State Water Quality Information System
SWRCB	State Water Resources Control Board
TDS	total dissolved solids
TIN	total inorganic nitrogen
TKN	Total Kjeldahl Nitrogen
TOC	total organic carbon
US	United States of America
USEPA	US Environmental Protection Agency
USGS	US Geological Survey
Watermaster	Chino Basin Watermaster
WCI	Water Character Index
WEI	Wildermuth Environmental, Inc.
WQS	water quality standard

1. INTRODUCTION

1.1 Background and Objective

The Nitrogen/Total Dissolved Solids Task Force (N/TDS Task Force) was formed in 1995/1996 to conduct studies regarding the TDS and nitrate-nitrogen objectives in the 1995 Water Quality Control Plan for the Santa Ana River Basin (Region 8) developed by the Regional Water Quality Control Board, Santa Ana Region (Regional Board). The N/TDS Task Force was comprised of 22 water supply and wastewater agencies and the project was administered by the Santa Ana Watershed Project Authority (SAWPA). After completion of the N/TDS Study, a new task force – the Basin Monitoring Task Force – was formed to implement the monitoring and analyses required in the January 2004 Basin Plan Amendment. (Hereafter, the Basin Monitoring Task Force will be referred to as the Task Force, while the original task force will be referred to as the N/TDS Task Force.)

In the January 2004 Basin Plan Amendment, the Regional Board states that, based on data generated during the N/TDS study, a conservative nitrogen-loss coefficient of 25 percent would be applied to all discharges that affect groundwater in the Region. A nitrogen-loss coefficient of 50 percent would be applied to discharges in Reach 3 of the Santa Ana River. Confirmation sampling to demonstrate nitrogen loss would be undertaken when a project proponent requests nitrogen-loss coefficient greater than 25 percent (other than in Reach 3 of the Santa Ana River). The 50 percent loss in Reach 3 of the Santa Ana River will be demonstrated by the Task Force. These demonstrations must utilize site-specific data. The length of the demonstration project will depend on the study design and robustness of the data set generated.

The following is an excerpt from the January 2004 Basin Plan Amendment:

> The Regional Board's regulatory program has long recognized that some nitrogen transformation and loss can occur when wastewater is discharged to surface waters or reused for landscape irrigation. For example, the Total Inorganic Nitrogen (TIN) wasteload allocation adopted for the Santa Ana River in 1991 included unidentified nitrogen losses in the surface flows in Reach 3 of the River. Waste discharge requirements have allowed for nitrogen losses due to plant uptake when recycled water is used for irrigation.
>
> In contrast, nitrogen has been considered a conservative constituent in the subsurface, not subject to significant transformation or loss, and no such losses have been identified or assumed for regulatory purposes.
>
> One of the tasks included in the Nitrogen/TDS Task Force studies leading to the 2004 update of the N/TDS Management Plan was the consideration of subsurface transformation and loss. One objective of this task was to determine whether dischargers might be required to incur costs for additional treatment to meet the new groundwater management zone nitrate-nitrogen objectives (Chapter 4), or whether natural, subsurface nitrogen losses could achieve any requisite reductions. The second objective was to develop a nitrogen loss coefficient that could be used with certainty to develop appropriate limits for nitrogen discharges throughout the Region.
>
> To meet these objectives, the Nitrogen/TDS study consultant, Wildermuth Environmental, Inc. (WEI), evaluated specific recharge operations (*e.g.*, the Orange County Water District recharge ponds overlying the Orange County Forebay), wastewater treatment wetlands (e.g., the Hidden Valley Wildlife Area, operated by the City of Riverside) and Santa Ana River recharge losses (for the Santa Ana River, water quality in reaches where recharge is occurring ("losing" reaches) was compared with local well data). In each case, WEI evaluated long-term (1954 to 1997) nitrogen surface water quality data and compared those values to long-term nitrogen data for adjacent wells.
>
> Based on this evaluation, a range of nitrogen loss coefficients was identified. [Ref. 1] In light of this variability, the N/TDS Task Force recommended that a conservative approach to be taken in establishing a loss coefficient. The Task Force recommended that a region-wide default nitrogen loss of 25% be applied to all discharges that affect groundwater in the Region. The Task Force also recommended that confirmatory,

> follow-up monitoring be required when a discharger requested and was granted the application of a nitrogen loss coefficient greater than 25%, based on site-specific data submitted by that discharger.
>
> The City of Riverside also presented data to the Task Force regarding nitrogen transformation and losses associated with wetlands. These data support a nitrogen loss coefficient of 50%, rather than 25%, for the lower portions of Reach 3 of the Santa Ana River that overlie the Chino South groundwater management zone. [Ref. 9]. In fact, the data indicate that nitrogen losses from wetlands in this part of Reach 3 can be greater than 90%. However, given the limited database, the Task Force again recommended a conservative approach, *i.e.*, 50% in this area, with confirmatory monitoring.
>
> The 25% and, where appropriate, 50% nitrogen loss coefficients will be used in developing nitrogen discharge limits. These coefficients will be applied to discharges that affect groundwater management zones with and without assimilative capacity.

This document is a work plan developed for the Task Force to determine a nitrogen-loss coefficient in Reach 3 of the Santa Ana River.

1.2 Outline of the Work Plan

Section 2 describes the proposed study locations, including the wells installed by the US Geological Survey (USGS) under the National Water Quality Assessment (NAWQA) Program and two wells owned and operated by the Santa Ana River Water Company (SARWC). Section 3 details the proposed field sampling program, while Section 4 analyzes preliminary groundwater quality samples collected from these wells and surface water samples collected from the Santa Ana River. These samples were collected as part of the Hydraulic Control Monitoring Program (HCMP) being conducted by the Chino Basin Watermaster and the Inland Empire Utilities Agency (IEUA). Sections 5 and 6 are Reporting and References, respectively.

2. STUDY LOCATIONS

2.1 Near-River Wells Proposed for Study

Past estimates of nitrogen loss in the Santa Ana River utilized data from private municipal wells in the general area. For the purpose of nitrogen loss calculations, these sites were problematic due to limited construction information, distance from the river and nitrogen point sources associated with overlying land uses. In 2000, the United States Geologic Survey (USGS), as part of the National Water-Quality Assessment (NAWQA) Program installed a series of shallow monitoring wells along Reach 3 of the Santa Ana River. Figure 2-1 depicts the location of those NAWQA wells. These wells more adequately meet the constraints necessary to be utilized for nitrogen loss calculations. All five well sites are within a 750 feet of the river (Table 2-1), the construction of all wells is known and all sites are located in open areas not likely to be subject to nitrogen sources associated with overlying land uses. Of the ten wells installed, eight are located in a reach of the Santa Ana River that past studies and models suggest is a losing reach – that is, the river is recharging groundwater. The two Park Headquarters wells are upstream of the losing reach of the river – upstream of the Riverside Narrows – and therefore will not be included in subsequent studies.

Table 2-1
Approximate Distances of the NAWQA and SARWC Well Sites to the Santa Ana River

Well Site	Owner	Approximate Distance from River Bank (ft)
Archibald	USGS	50
HSA	USGS	200
Park HQ	USGS	750
RRXing	USGS	10
US I-15	USGS	10
Well 9	SARWC	1100
Well 11	SARWC	650

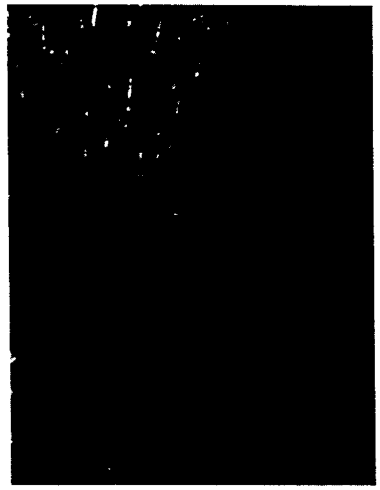
Table 2-2
Site Information for NAWQA and SARWC Wells

Well Name	Owner	Well Location		Well Depth (ft)	Perforations (ft)		Elevation Ground Surface (ft)
		UTMX	UTMY		Top	Bottom	
Archibald 1	USGS	445086	754390	85	75	85	540
Archibald 2	USGS	445086	754390	50	40	50	540
HSA 1	USGS	452290	759182	96	86	96	640
HSA 2	USGS	452290	759182	64	54	64	640
HSA 3	USGS	452290	759182	31	26	31	640
Park HQ 1	USGS	462245	759672	45			750
Park HQ 2	USGS	462245	759672	85	75	85	750
RRXing	USGS	459814	758558	17	12	17	700
US I-15 #1	USGS	449157	756244	26	21	26	600
US I-15 #2	USGS	449157	756244	17	12	17	600
Well 9	Santa Ana River Water Company	451960	758899	213	113	213	660
Well 11	Santa Ana River Water Company	452168	759309	226	75 155	135 230	683

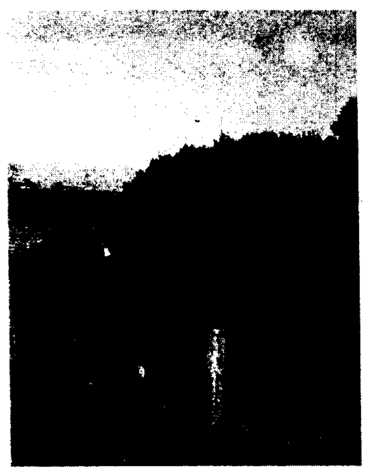
To supplement the data, two Santa Ana River Water Company wells will also be sampled. Table 2-2 summarizes the available well location and depth information for the NAWQA and SARWC wells.

2.1.1 NAWQA Wells

The NAWQA wells were reconnoitered and inspected by WEI staff on September 8, 2003. After locks and well covers were replaced, all sites were determined to be in a usable condition. Severe erosion has displaced much of the soil around the HSA well casing. As of now, the well is usable but future weather events could lead to further instability and render the site unusable. Photographs 2-2 through 2-6 depict the NAWQA wells to be utilized in this study.



Photograph 2-1
WEI staff measure groundwater levels at the Archibald Site.



Photograph 2-2
The US I-15 Site – US I-15 is located in the background.

Photograph 2-3
Groundwater level measurements are conducted at the HSA Site.

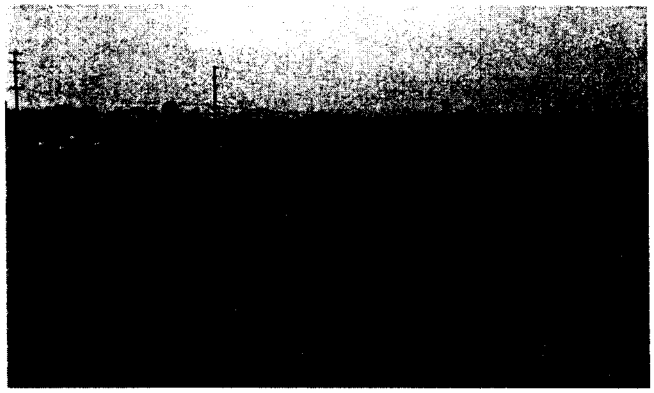
Photograph 2-4
At the HSA site, the ground is severely eroded just beyond the well casing.

Photograph 2-5
The well casing at the RRXing site.

During the first round of sampling March 15-17, 2004, it was determined that the US I-15 site wells had been silted in by high river flows during the winter. On March 26, 2004, both US I-15 wells were bailed to remove the extra sediment and restore the complete depth of the wells.

2.1.2 SARWC Wells

Two Santa Ana River Water Company wells are proposed to be included in the study to augment the data. Figure 2-1 shows the location of both wells. Well 11 (Figure 2-7) is a monitoring well located approximately 300 ft away from the NAWQA HSA wells. The well has two perforations located at 75 to 135 and 155 to 230 feet below ground surface. Well 9 (Figure 2-8) is an active well used by the Santa Ana River Water Company to provide domestic water to area residences.



Photograph 2-6
SARWC Well 11 is located uphill from the HSA wells.
Vegetation from the Santa Ana River can be seen in the background.

Photograph 2-7
Pump house and sampling port of SARWC Well 9.

situ aqueous/colloid ratio and does not introduce immobile artifactual particles to the sample, therefore encouraging horizontal flow, and eliminating turbidity (no need for filtering) and sample bias.

Low-flow purging equipment will include a QED MicroPurge® Purge System or equivalent consisting of the following: MP-SP bladder pump, MP-10 controller, MP-40 gasoline-powered oil-less compressor (125 PSI, 250 feet of lift), ¼-inch polyethylene air inlet/discharge tubing, YSI-556 200 ml flow cell (pH, electrolytic conductivity (EC), salinity, and temperature), and a water level meter. To minimize the potential for cross-contamination between wells and reduce time required for equipment decontamination, removable bladders and appropriate lengths of polyethylene air inlet/discharge tubing will be prepared, labeled, and dedicated to each USGS NAWQA and SARWC monitoring well.

Photograph 3-1
Polyethylene tubing connects the pump to the control box (mid) and the flow cell (foreground).

The pump will be decontaminated between wells by disassembling the pump, removing the reusable dedicated bladder, spraying all surfaces and orifices with distilled water, and reassembling the pump with another reusable dedicated bladder.

Photograph 3-2
A pump bladder is dedicated to each well.
Between samples the dedicated bladder is switched and the apparatus is decontaminated.

Field personnel will abide by the following low-flow field protocol when sampling the USGS NAWQA and SARWC monitoring wells:

1. Field calibrations of pH, temperature, and EC meters will be performed each day prior to sample collection, according to the manufacturer's specifications.
2. Measure static water level to the nearest 0.01 foot.
3. Slowly install pump to target stratum/depth to minimize mixing of overlying stagnant casing water and disturbance of normally immobile/settled particles.
4. Adjust purge rate to allow a maximum of 1 meter (3.1 feet) of drawdown with a constant discharge rate.
5. Purge groundwater at a rate of 0.1-1.0 L/min (0.026-0.26 gpm).
6. Periodically monitor the water level as pumping continues, enter measurements into the field notebook.
7. Measurements of the groundwater parameters pH, temperature, and EC will be taken and recorded in the field notebook. Observations of clarity, color, and odor of the sample water will also be noted and recorded.
8. Purge groundwater until three successive readings have stabilized as follows: temperature (± 0.5°C); pH (± 0.2 units); and EC (± 3.0-5.0%).

SARWC Active Well Purging. Local demands for groundwater when this well is sampled will determine whether the status is pumping or static. If the well is static, the well will be turned on to allow purging of groundwater prior to sampling. If the well is being actively pumped, it will be allowed to continue pumping. For either status, the following groundwater parameters will be monitored until they have stabilized as outlined below:

1. Groundwater parameter meters will be calibrated per manufacturer's guidelines at the beginning of each day.
2. Water level will be measured to the nearest 0.01 foot and the pump status noted.
3. Measurements of pH, temperature, and EC will be taken and recorded in the field notebook. Observations of clarity, color, and odor of the sample water will also be noted and recorded. Discharge rate and pumping water level (if a measuring port is available) will also be recorded during purging.

3.1.2 Groundwater Sample Collection

Once groundwater parameters measurements have stabilized, the procedures below will be followed each time a groundwater well is sampled:

1. Personnel collecting samples will wear clean, new, disposable latex gloves that will be replaced prior to collecting each sample.

2. Unfiltered groundwater samples will be collected from a discharge port (Non-monitoring wells) or the polyethylene discharge tubing (USGS NAWQA and SARWC monitoring wells) in a manner that will minimize agitation and aeration.
3. Water samples will be placed in appropriate, labeled sample bottles supplied by the analytical laboratory.
4. Sample bottles will then be placed in a cooler, chilled, and delivered to the analytical laboratory for chemical analysis.

3.1.3 Sample Labeling, Handling, Packaging, and Shipping

Sample Labeling. Sample labels will be filled out with indelible ink and uniquely numbered. Groundwater samples collected in glass containers will be capped immediately following collection. Labels may be partially completed prior to sample collection. The date, time, sampler's initials, and the sample identification number should not be completed until the time of sample collection. At a minimum, each numbered label shall contain the following information:

- Project name;
- Project number;
- Well number (Watermaster Recordation Number);
- Date and time of sample collection;
- Sampler's initial;
- Analyses required; and
- Preservatives (if applicable).

Sample Handling. Samples will be placed in sealable plastic bags and stored in a cooler chilled to approximately 4°C. At the end of the workday, the cooler will be delivered to the designated analytical laboratory for testing either by a member of the field crew or by a bonded courier.

Groundwater samples will be collected in appropriate containers supplied by the analytical laboratory. Groundwater samples will be placed on ice or a chemical ice substitute in a portable insulated cooler immediately following sample collection. Preservatives required for water samples will be added to the appropriate container by the laboratory prior to sample collection.

Sample Packaging. A completed chain-of-custody form for each cooler will be prepared and placed in a resealable plastic bag and taped to the inside of the cooler lid. Coolers will be wrapped with strapping tape at two locations to secure lids.

Sample Shipping. Collected samples will be delivered to the designated analytical laboratory for testing by a member of the field crew or by a bonded courier. Sample transportation will follow EPA and Department of Transportation (DOT) regulations.

3.1.4 Sample Documentation and Tracking

Sample Documentation. Documentation of observations and data acquired in the field will provide information on the acquisition of samples and a permanent record of field activities. The observations and data will be recorded with indelible ink in a permanently bound weatherproof field book with consecutively numbered pages and, if applicable, on field sampling data sheets.

The information in the field book will include the following as a minimum.

- Project name;
- Location of sample;
- Sampler's signature;
- Date and time of sample collection;
- Sample identification numbers and sample depth (if applicable);
- Description of samples (matrix sampled);
- Analysis to be performed;
- Number and volume of samples;
- Description of quality assurance/quality control (QA/QC) samples (if collected);
- Sample methods;
- Sample handling;
- Field observations; and
- Personnel and equipment present.

Changes or deletions in the field book should be lined out with a single strike mark, initialed, and dated by the person making the change, and remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without relying on the sample collector's memory. The person making the entry will sign each page of the field book. Anyone making entries in another person's field book will sign and date those entries.

Sample Tracking. During field sampling activities, traceability of the sample must be maintained from the time the samples are collected until laboratory data are issued. Information on the custody, transfer, handling, and shipping of samples will be recorded on a Chain-of-Custody (CoC) form. The CoC is a one-page form.

The sample handler will be responsible for initiating and filling out the CoC form. The sampler will sign the CoC when the sampler relinquishes the samples to anyone else, including the bonded courier. A CoC form will be completed for each cooler of samples collected daily, and will contain the following information:

- Sampler's signature and affiliation;
- Project number;
- Date and time of collection;
- Sample identification number;
- Sample type/matrix;
- Analyses requested;
- Number of containers;
- Person to contact regarding analyses;
- Signature of persons relinquishing custody, dates, and times;
- Signature of persons accepting custody, dates, and times (laboratory); and
- Method of shipment.

The person responsible for delivery of the samples to the laboratory will sign the CoC form and document the method shipment. Upon receipt at the laboratory, the person receiving the samples will sign the CoC form. Copies of the CoC forms and all custody documentation will be received and kept in the central files. The original CoC forms will remain with the samples until final disposition of the samples by the laboratory. The analytical laboratory will dispose of the samples in an appropriate manner 60 to 90 days after data reporting. After sample disposal, a copy of the original CoC will be sent to the Project Manager by the analytical laboratory to be incorporated into the central files.

3.2 Analyze Groundwater Samples

Watermaster will solicit proposals from qualified and licensed environmental laboratories to provide analytical testing of groundwater samples for the parameters listed in Section 3.2..2. The commercial environmental laboratory selected will be certified under both the Environmental Laboratory Accreditation Program (ELAP) and National Environmental Laboratory Accreditation Conference (NELAC).

- The California Environmental Laboratory Improvement Act (Department-sponsored Assembly Bill 3739, Chapter 894, Statutes of 1988) took effect on January 1, 1989 and the ELAP is administered through the DHS. Under the Act, accreditation is required of an environmental laboratory for producing analytical data for California regulatory agencies.
- NELAC is sponsored by the US Environmental Protection Agency (EPA) as a voluntary association of state and federal officials to foster the generation of environmental laboratory data of known and documented quality through the adoption of national performance standards for environmental laboratories accredited under the National Environmental Laboratory Accreditation Program (NELAP).

3.2.1 Project Management and Invoicing

The laboratory selected shall designate a project manager for this monitoring program. There will be no change in project manager during the duration of this contract without prior written approval by Watermaster. The project manager's responsibilities will include ensuring that appropriate quality control/quality assurance procedures are strictly followed, that the samples are processed in a timely manner, and that all reporting is done according to the scope of work. The project manager will serve as the point-of-contact between Watermaster staff and the analytical laboratory.

The analytical laboratory shall not subcontract any work without the prior written permission from Watermaster. Proper subcontractor chain-of-custody procedures must be followed if samples are sent to a subcontract laboratory.

The analytical laboratory shall invoice Watermaster on a monthly basis. The invoice shall include the following information, at a minimum:

- invoice number;
- date of invoice;
- invoice period;
- client name (Watermaster);
- project name (Hydraulic Control Monitoring Program);
- purchase order (PO) or contract number;

- matrix or table with the following columns:
  - samples analyzed during invoice period
  - dates the samples were collected, received, and analyzed
  - test procedures
  - price
  - surcharge (if any)
  - test total
- total cost for the current invoice period;
- project not-to-exceed amount;
- remaining budget.

The invoice must be signed by the laboratory project manager.

3.2.2 Laboratory Services and Analytical Requirements

Groundwater samples will be tested for the analytes listed in Table 3-1.

Table 3-1
List of Analytes for Groundwater and Surface Water Analyses in N-Loss Study

Analytes	Method	Wells
Alkalinity	EPA 310.1/SM 2320B	All
Apparent Color	SM 2120B	All
ClO_4	EPA 314	All
Major anions: Cl, SO_4, NO_2, NO_3	EPA 300.0	All
Major cations: K, Na, Ca, Mg,	EPA 200.7	All
NH_3	EPA 350.1	All
Odor	SM 2150B	All
pH	EPA 150.1/SM 4500-HB	All
Specific Conductance	SM2510B	All
TDS	EPA 160.1/SM 2540C	All
Total Kjeldahl Nitrogen (TKN)	EPA 351.4	All
Total Phosphorus	EPA 365.1	All
Turbidity	EPA 180.1	All

3.2.3 Sample Containers

The analytical laboratory shall provide all necessary new or certified-clean sample bottles required for the sampling program (Sample containers and preservatives are listed in Table 3-2). The analytical laboratory shall provide sample labels for all sample bottles. Reagent-grade preservatives shall be added to the appropriate sample containers. To the extent logistically possible, these bottles shall be pre-labeled, identifying – at a minimum – the analyses requested and the preservative used, if any. The analytical laboratory shall actively participate in a sample container quality assurance program. The analytical laboratory shall provide appropriately-sized coolers and sufficient chemical ice.

3.2.4 Chain-of-Custody

The analytical laboratory shall provide electronic chain-of-custody forms for sample coolers. One chain-of-custody shall be sent with each sample set sent to the analytical laboratory.

3.2.5 Transportation

The analytical laboratory may provide transportation services for the pick-up of empty sample containers/coolers from the laboratory and delivery of samples to the laboratory, in addition to Watermaster's bonded courier or delivery by field crew.

3.2.6 Sample Control

Any sample received by the analytical laboratory in an unacceptable condition shall be reported to the designated contact person on Watermaster staff within 48 hours. Likewise, Watermaster shall be notified if any samples become unusable while in the laboratory's possession – this includes violations of holding times.

The analytical laboratory shall be responsible for all costs associated with re-sampling that is deemed necessary through errors caused by the analytical laboratory.

3.2.7 Laboratory Quality Control

The analytical laboratory must maintain rigorous QA/QC procedures. Laboratory procedures are documented by the analytical laboratory. Internal QC procedures for analytical services will be conducted by the analytical laboratory in accordance with their corporate QA plan and standard operating procedures (SOPs). These specifications include the types of QC checks or standards required (sample spikes, surrogate spikes, reference samples, controls), the frequency of each QC check or standard, the compounds to be used for sample spikes and surrogate spikes, and the QC acceptance criteria for these QC checks or standards. Requirements for precision and accuracy are listed in Table 3-3.

The laboratory will document that analytical QC functions have been met in each data package. If the laboratory procedures were not in control as assessed by laboratory control samples and other data specific to the analysis and if sufficient sample volume is available, samples analyzed in nonconformance with the QC criteria will be reanalyzed by the laboratory. It is expected that sufficient volume of samples will be collected for reanalysis. The laboratory will follow the corrective action guidelines provided in their standard operating procedures. The following information must be included in the laboratory's QA/QC manual or as separate documentation:

- copy of certificate that laboratory is currently certified in the State of California Department of Health Services ELAP;
- copy of certificate that the laboratory is currently certified to perform perchlorate analyses with low detection limits under the DHS ELAP;
- fields of testing (FOT) for which the laboratory holds an ELAP accreditation;
- sample preservation, holding times, sample containers (type and number) per analyte group;
- internal chain-of-custody procedures (sample receipt and tracking);
- record keeping protocols;
- maintenance and calibration of instruments;

- use of standards and references;
- internal QC procedures, including corrective actions;
- determination of method detection limits (MDLs);
- determination of minimum reporting levels (MRLs);
- sample container QC program;
- data flags, qualifiers, reporting procedures;
- laboratory information management system (LIMS) and data reports;
- laboratory organization chart; and
- resumes of key personnel.

3.2.8 Reporting and Information Management

The analytical laboratory shall provide hard copy laboratory reports of the analyses of each of the samples. The report shall contain, at a minimum:

- sample name;
- sample number;
- date and time sampled;
- date and time extracted and/or prepared;
- date and time analyzed;
- analysis method;
- dilutions (if appropriate);
- results of duplicates;
- analytes;
- species of analyte as reported (*e.g.*, nitrate as NO_3 or nitrate as N);
- reporting limits;
- units;
- results; and
- qualifier(s).

The hard copy laboratory report shall be submitted to Watermaster within 30 days of the receipt of the sample by the laboratory. A copy of the chain-of-custody shall be attached to the hard copy report. Watermaster reserves the right to assess a late-fee of one (1) percent per day that the reports exceed the delivery due date. Electronic data reports must be submitted within 45 days of the receipt of the sample by the laboratory. Electronic data reports will be queried from the LIMS on a once-a-month basis.

The electronic data report will be electronically-mailed (e-mailed) to the following addresses:

- Frank Yoo (Watermaster) [franky@cbwm.org]
- Elisha Wakefield (WEI) [ewakefield@wildh2o.com]

3.2.9 Record Keeping and Archival of Reports

The analytical laboratory shall maintain all documents, raw data, and supporting QC data for the analyses associated with this project for a minimum of ten (10) years. The analytical laboratory must supply all pertinent data to Watermaster within one (1) week of a written request without any additional cost to Watermaster.

The analytical laboratory shall not disclose the results of the analyses or disseminate data or copies of any reports without written permission from Watermaster.

3.2.10 Disposal and Waste Handling

The analytical laboratory shall comply with all applicable Federal, State, and local regulations and laws concerning the disposal of Watermaster's samples and associated laboratory waste.

3.3 Surface Water Flow and Water Quality Data

An estimate of nitrogen loss from surface waters will be accomplished by conducting sampling events at a regular frequency at key locations on the Santa Ana River and comparing water quality to that determined for groundwater sampled at the same time.

3.3.1 Select Surface Water Stations

The Santa Ana River will be sampled at sites adjacent to the NAWQA well locations. These sites are depicted in Figure 2-1.

3.3.2 Collect and Analyze Grab Surface Water Samples

Concurrent with well sampling, field crews will collect grab samples from the Santa Ana River at stations located approximately 100 meters (310 feet) upgradient of the NAWQA wells. At each station, one discrete surface water sample will be collected at approximately 50 percent of the distance measured along a transect oriented normal to river flow.

Surface water samples will be tested for the same set of analytes as groundwater (Table 3-1).

3.3.3 Collect Flow and Surface Water Quality Data from Cooperating Agencies

As necessary, data will be collected from the permanent USGS stations from the following website: http://waterdata.usgs.gov/nwis/discharge. Discharge data will be collected from the Publicly-Owned Treatment Works (POTW) operators on an on-going basis.

Table 3-2
Analytes: Preservation, Holding Times, Sample Size, and Containers

Analyte	EPA/SM Method Number	Preservative	Sample Holding Time	Extract Holding Time	Sample Size	Type of Container
Ammonia-N	EPA 350.1	Cool, 4°C 0.5 mL, H_2SO_4 to pH<2	28 days	–	125 mL	Plastic
Anion sum	calculated	–	–	–	–	–
Calcium	EPA 200.7	0.5 mL, H_2SO_4 to pH<2	6 months	–	500 mL	Plastic
Cation sum	calculated	–	–	–	–	–
Chloride	EPA 300.0	none	28 days	–	125 mL	Plastic
Color	SM 2120B	Cool, 4°C	48 hours	–	500 mL	Plastic
Nitrate-N	EPA 300.0	Cool, 4°C	28 days	–	125 mL	Plastic
Nitrite-N	EPA 300.0	Cool, 4°C	48 hours	–	125 mL	Plastic
Odor	SM 2150B	Cool, 4°C	24 hours	–	500 mL	Glass
Perchlorate	EPA 314	Cool, 4°C	28 days	–	125 mL	Plastic
pH	EPA 150.1/SM 4500-HB	Cool, 4°C	7 days	–	125 mL	Plastic
Potassium	EPA 200.7	0.5 mL, H_2SO_4 to pH<2	6 months	–	500 mL	Plastic
Sodium	EPA 200.7	0.5 mL, H_2SO_4 to pH<2	6 months	–	500 mL	Plastic
Sulfate	EPA 300.0	Cool, 4°C	28 days	–	125 mL	Plastic
Total Alkalinity	SM 2320B	Cool, 4°C	14 days	–	100 mL	Plastic
Total Dissolved Solids	SM 2540C	Cool, 4°C	7 days	–	125 mL	Plastic
Total Kjeldahl Nitrogen	EPA 351.2	0.5 mL H_2SO_4 (50%)	28 days	–	125 mL	Plastic
Total Phosphorus	SM 4500PE/EPA 365.1	0.5 mL H_2SO_4 (50%)	28 days	–	250 mL	Plastic
Turbidity	EPA 180.1	Cool, 4°C	48 hours	–	125 mL	Plastic

"–" = not applicable

Table 3-3
Analytes: Accuracy and Precision

Analyte	EPA/SM Method Number	Accuracy: Laboratory Control Sample % Recovery	Accuracy: Matrix Spike % Recovery	Precision: % Relative Percent Difference (RPD) Maximum
Ammonia-N	EPA 350.1	90 - 110	80 - 110	20
Anion sum	calculated	–	–	–
Calcium	EPA 200.7	85 - 115	70 - 130	20
Cation sum	calculated	–	–	–
Chloride	EPA 300.0	90 - 110	80 - 120	20
Color	SM 2120B	–	–	–
Nitrate-N	EPA 300.0	90 - 110	80 - 120	20
Nitrite-N	EPA 300.0	90 - 110	80 - 120	20
Odor	SM 2150B	–	–	–
Perchlorate	EPA 314	85-115	80-120	20
pH	EPA 150.1/SM 4500-HB	+/– 0.1	–	10
Potassium	EPA 200.7	85 - 115	70 - 130	20
Sodium	EPA 200.7	85 - 115	70 - 130	20
Sulfate	EPA 300.0	90 - 110	80 - 120	20
Total Alkalinity	SM 2320B	90 - 110	80 - 120	15
Total Dissolved Solids	SM 2540C	85 –115	–	10
Total Kjeldahl Nitrogen	EPA 351.4	90-110	90-110	20
Total Phosphorus	EPA 365.1	90 –110	80 – 120	20
Turbidity	EPA 180.1	90 –110	80 – 120	10

"–" = not applicable

4. ANALYSES OF PRELIMINARY DATA

4.1 Surface Water Sample Transect

During the March 15, 2004 sampling event, three surface water samples were collected at the Archibald site. These samples were collected in a transect across the Santa Ana River at approximately 25, 50 and 75 percent of the width of the river. These sample results are provided in Table 4-1 and the concentrations of the major cations and anions are shown in Figure 4-1. The largest variation in the major ions was two percent. Therefore, for subsequent surface water stations, one sample collected near the center of the river was deemed to be representative. Fifteen rounds of samples at those four locations, in addition to other surface water samples collected as part of the HCMP will provide a robust dataset.

4.2 Preliminary Data from Initial Three Rounds of Samples – Spring 2004

Watermaster and IEUA, as part of the HCMP, collected three rounds of samples in Spring 2004: March 15, 2004, April 5, 2004, and April 28, 2004. Another round of samples will be collected in mid-June 2004. The analytical results are summarized in Table 4-1. Adobe Acrobat pdf files of all laboratory reports and an Access database will be included in Appendix A of the final work plan.

4.3 Preliminary N-Loss Estimates

In order to estimate nitrogen loss, the wells that are being recharged by the Santa Ana River need to be determined. For example, detailed groundwater flow modeling suggests that the reach of the river near the Archibald site is a gaining reach. The concentrations of TDS (>1000 mg/L) and nitrate (> 60 mg/L) are also indicative a source of water other than the Santa Ana River. Piper diagrams were prepared for each of the stations. A trilinear or Piper diagram is a graphical means of displaying the ratios of the principal ionic constituents in water (Piper, 1944; Watson and Burnett, 1995). The piper diagrams are displayed in Figures 4-2 through 4-5.

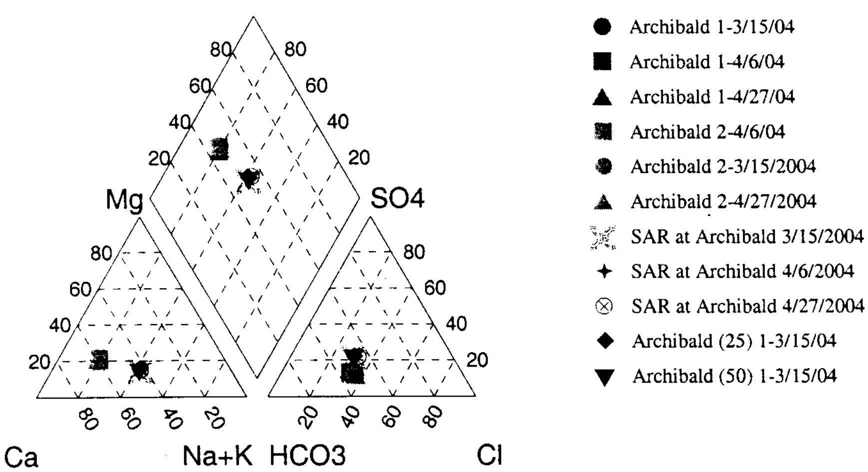


Figure 4-2
Piper Diagram for the Archibald Site

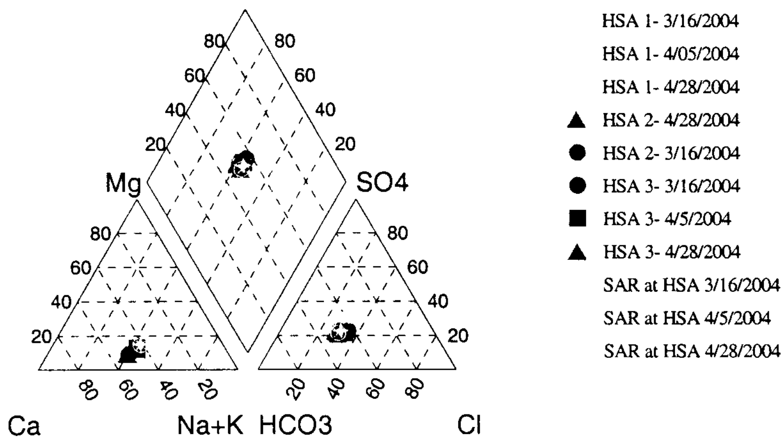


Figure 4-3
Piper Diagram for the Horse Staging Area Site

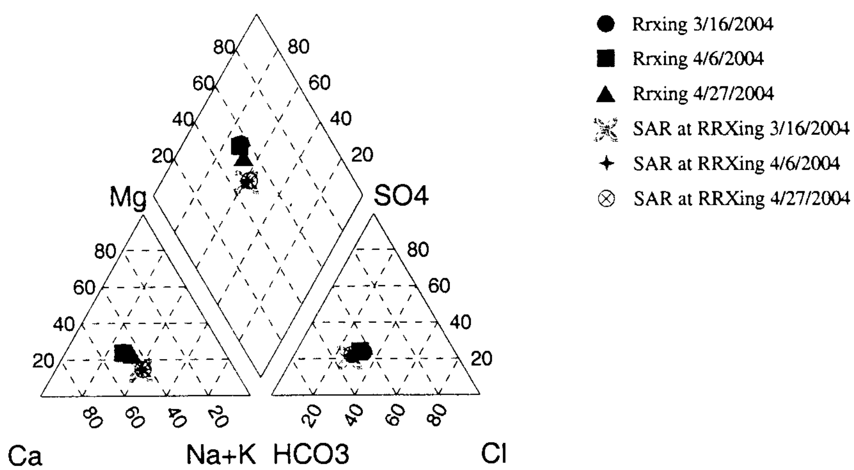


Figure 4-4
Piper Diagram for the Railroad Crossing Site.

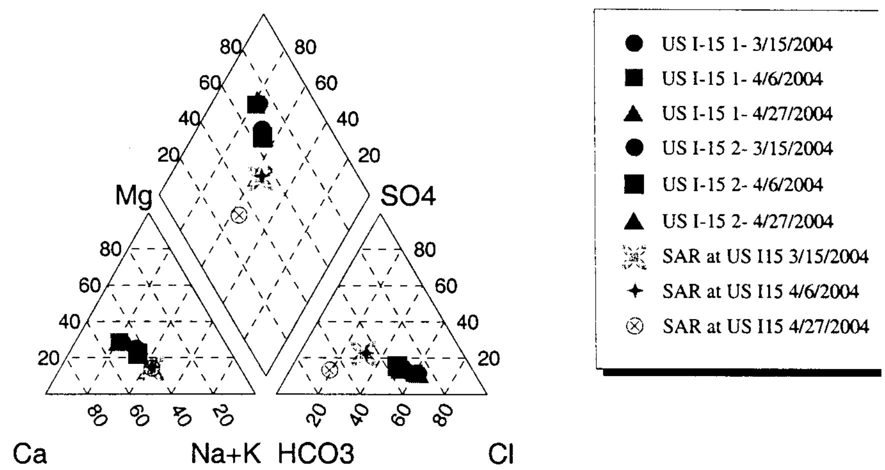


Figure 4-5
Piper Diagram for the US I-15 Site.

As shown in the figures, the Archibald and RRXing wells have general water chemistry that is similar to groundwater chemistry in the southern part of Chino Basin: Ca-Mg-HCO_3-Cl, while the US I-15 wells have a sodium chloride component: Ca-Mg-Na-Cl-HCO_3. The Archibald and RRXing wells are in areas of Reach 3 where modeling results suggest there is rising groundwater. The I-15 well should be in an area of Reach 3 that is a losing reach, but these wells were heavily silted in during the winter of 2003/2004 and were bailed in an attempt to remove sediment and rehabilitate the wells.

The two shallow HSA wells (HSA-2, HSA-3) have a sulfate component and their chemistry is very similar to the Santa Ana River: Ca-Na-HCO_3-Cl-SO_4. The two SARWC wells sampled have similar Piper diagrams to the two shallow HSA wells. The deeper HSA well reflects a mixture of surface water and groundwater. Based on this analyses, nitrogen loss estimates were based on only using the total nitrogen concentrations for HSA-2, HSA-3, SARWC-9, and SARWC-11.

Total Nitrogen (TN) is the sum of all nitrogen forms:

$$TN = TKN + NO_2 + NO_3$$

where:

TKN = Total Kjeldahl Nitrogen
NH_3 = ammonia nitrogen
NO_2 = nitrite
TKN = Total Kjeldahl Nitrogen

NO_3 = nitrate
TKN = NH_3 + Organic Nitrogen (derived from amino acids and proteins)

The average total nitrogen for Reach 3 of the Santa Ana River during the three sampling rounds in Spring 2004 was 7.9 mg/L (Table 4-2). The average total nitrogen for groundwater in HSA-2, HSA-3, SARWC-9, and SARWC-11 was 2.6 mg/L (the concentrations for the two perforated intervals in SARWC-11 were average prior to the overall groundwater average, thus the results for this well were treated as one value, rather than two). For the three rounds conducted in Spring 2004, the average nitrogen loss coefficient was 68 percent.

Table 4-1

Preliminary Water Quality Results in the Santa Ana River and in Near River Wells

Station	Data Source	Sample Date	Alkalinity in CaCO3 units (mg/L)	Ammonia as Nitrogen (mg/L)	Anion Sum (CALC) (meq/L)	Apparent Color (ACU)	Calcium (mg/L)	Cation Sum (CALC) (meq/L)	Chloride (mg/L)	Kjeldahl Nitrogen (mg/L)	pH	Magnesium (mg/L)	Nitrate as Nitrogen (mg/L)	Nitrite as Nitrogen (mg/L)	Odor (TON)	Perchlorate (µg/L)	Potassium (mg/L)	Sodium (mg/L)	Specific Conductance (µmhos/cm)	Total Dissolved Solids (mg/L)	Total Phosphorus-P (mg/L)	Turbidity NTU
Groundwater Wells																						
Archibald 1	USGS	[illegible]	408	0.022						0.43	7.1		[illegible]	ND					1690	1082^{A}	0.021	
Archibald 1	CBWM/IEUA	3/15/2004	418	ND	20.5	5	250	20.6	180	ND	7.3	50	70	ND	4	ND	4.2	90	1930	1390	0.05	0.5
Archibald 1	CBWM/IEUA	4/6/2004	427	ND	20.3	3	240	20	180	ND	7.6	50	66	ND	2	ND	4.2	88	1930	1235^{A}	ND	0.6
Archibald 1	CBWM/IEUA	4/27/2004	421	ND	20.8	3	250	20.8	190	ND	7.4	52	69	ND	3	ND	4.3	91	1920	1229^{A}	ND	0.65
Archibald 2	USGS	[illegible]	[illegible]	[illegible]						0.36	[illegible]		[illegible]	ND					[illegible]	[illegible]	0.025	
Archibald 2	CBWM/IEUA	3/15/2004	472	ND	23.7	5	290	24.1	230	ND	7.2	62	80	ND	4	ND	5	100	2240	1640	0.06	26
Archibald 2	CBWM/IEUA	4/6/2004	486	ND	24.3	3	290	24.2	230	ND	7.2	63	82	ND	1	ND	5.1	100	2250	1440^{A}	ND	59
Archibald 2	CBWM/IEUA	4/27/2004	478	ND	24.5	3	290	24.1	240	ND	7.2	62	85	ND	3	ND	5	100	2240	1434^{A}	0.06	33
HSA 1	USGS	[illegible]	[illegible]	[illegible]						ND	[illegible]		[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	
HSA 1	CBWM/IEUA	3/16/2004	145	ND	7.86	15	110	8.4	86	ND	7.7	11	3.4	ND	4	ND	3.3	44	780	510	0.08	57
HSA 1	CBWM/IEUA	4/5/2004	155	ND	8.19	10	100	7.81	90	ND	7.7	10	3.6	ND	2	ND	2.9	44	829	531^{A}	0.02	8.7
HSA 1	CBWM/IEUA	4/28/2004	154	ND	7.93	3	110	8.31	89	ND	7.9	10	3.6	ND	2	ND	2.9	44	784	502^{A}	0.01	3.5
HSA 2	USGS	[illegible]	224	ND						ND	[illegible]		[illegible]	ND					[illegible]	[illegible]	0.017	
HSA 2	CBWM/IEUA	3/16/2004	203	ND	8.75	5	93	9.17	88	ND	7.6	10	4.4	ND	4	ND	3.4	83	878	560	0.05	38
HSA 2	CBWM/IEUA	4/5/2004	212	ND	9	5	93	9.07	89	ND	7.6	9.9	4.4	ND	1	ND	3.2	81	938	600^{A}	ND	2.2
HSA 2	CBWM/IEUA	4/28/2004	209	ND	8.69	3	96	9.4	83	0.22	7.8	10	4.4	ND	3	ND	3.3	85	875	560^{A}	0.02	1.3
HSA 3	USGS	11/9/2001	414	0.471						0.75	7.3		0.09	0.233					1330	851^{A}	0.063	
HSA 3	CBWM/IEUA	3/16/2004	308	0.548	14.1	15	130	14.5	170	0.79	7.4	22	ND	ND	4	ND	4.1	140	1340	840	0.16	2.7
HSA 3	CBWM/IEUA	4/5/2004	315	ND	13.7	10	120	13.5	160	0.65	7.4	21	ND	ND	4	ND	3.9	130	1390	90^{A}	0.11	1.4
HSA 3	CBWM/IEUA	4/28/2004	325	0.42	13.2	10	120	13.3	140	1.1	7.7	19	ND	ND	3	ND	3.8	130	1270	83^{A}	0.09	1.7
RR_Xing	USGS	[illegible]	[illegible]	ND						[illegible]	[illegible]		[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	
RR_Xing	CBWM/IEUA	3/16/2004	330	ND	15.2	20	160	16.4	170	0.45	7.3	48	3.7	ND	4	ND	7.1	99	1460	960	0.45	137
RR_Xing	CBWM/IEUA	4/6/2004	315	ND	14.1	10	140	14.3	150	0.4	7.3	41	3	ND	3	ND	5.7	87	1340	858^{A}	0.3	27
RR_Xing	CBWM/IEUA	4/27/2004	284	ND	12.5	5	110	12.3	130	0.34	7.7	34	2.9	0.82	2	ND	5.4	89	1190	762^{A}	0.29	8.2
US I-15 1	USGS	[illegible]	[illegible]	ND						[illegible]	[illegible]		[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	
US I-15 1	CBWM/IEUA	3/15/2004	205	ND	15.9	15	160	16.2	330	2.9	7.5	56	11	ND	17	6.5	8.3	78	1560	1150	0.58	349
US I-15 1	CBWM/IEUA	4/6/2004	186	ND	13.5	10	140	13.8	270	0.42	7.4	48	10	ND	4	6.4	5.5	63	1390	890^{A}	0.09	67
US I-15 1	CBWM/IEUA	4/27/2004	186	ND	14.9	3	150	14.7	310	ND	7.6	51	12	ND	3	6.2	5.1	66	1440	922^{A}	0.01	7.9
US I-15 2	USGS	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]		[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	
US I-15 2	CBWM/IEUA	3/15/2004	460	ND	28.4	20	280	31.5	520	5.8	7.2	96	8.2	ND	17	ND	19	210	2500	1680	1.4	1208
US I-15 2	CBWM/IEUA	4/6/2004	477	ND	27.9	10	270	29.9	480	0.38	7.1	80	9	ND	1	ND	11	220	2660	1702^{A}	0.09	41
US I-15 2	CBWM/IEUA	4/27/2004	479	ND	26.7	5	260	29.2	520	0.74	7.3	77	9.9	ND	3	ND	10	220	2690	1722^{A}	0.06	11
SARWC 9	CBWM/IEUA	3/16/2004	201	ND	9.52	5	110	9.9	110	ND	7.7	13	1.4	ND	3	ND	3.1	75	946	600	0.03	0.55
SARWC 9	CBWM/IEUA	4/5/2004	204	ND	9.57		110	9.85	110	0.22	7.6	13	1.4	ND	1	ND	3	74	993	636^{A}	ND	0.05
SARWC 9	CBWM/IEUA	4/27/2004	202	ND	9.53	3	110	9.91	110	0.23	8	13	1.4	ND	3	ND	3	75	941	602^{A}	ND	0.05
SARWC 11 (Top Perf)	CBWM/IEUA	3/17/2004	231	ND	9.26	5	97	9.58	90	ND	7.7	11	3.1	ND	2	ND	3.2	86	933	570	0.02	0.3
SARWC 11 (Top Perf)	CBWM/IEUA	4/5/2004	229	ND	9.45	3	98	9.32	95	1.2	7.7	11	3.2	ND	2	ND	3	79	960	614^{A}	ND	0.2
SARWC 11 (Top Perf)	CBWM/IEUA	4/28/2004	225	ND	8.95	3	95	9.43	85	ND	7.8	11	3	ND	2	ND	3.1	85	902	577^{A}	ND	0.25
SARWC 11 (Bot Perf)	CBWM/IEUA	3/17/2004	232	ND	9.28	5	96	9.57	90	ND	7.7	20	3.1	ND	2	ND	3.1	87	909	580	0.03	6.9
SARWC 11 (Bot Perf)	CBWM/IEUA	4/5/2004	229	ND	9.34	10	96	9.44	93	0.21	7.5	11	3.1	ND	2	ND	3.1	84	963	616^{A}	ND	9
SARWC 11 (Bot Perf)	CBWM/IEUA	4/28/2004	225	ND	8.99	3	96	9.43	85	0.25	7.8	11	3.1	ND	2	ND	3	84	893	570^{A}	ND	1.8
Santa Ana River Samples																						
SAR at Archibald	CBWM/IEUA	3/15/2004	222	0.052	9.86	20	92	10.6	100	0.87	8.2	20	7.2	ND	8	ND	11	94	992	640	1	26
SAR at Archibald	CBWM/IEUA	3/15/2004	222	0.058	9.87	20	91	10.5	100	0.74	8.2	19	7	ND	8	ND	11	94	978	620	1	32
SAR at Archibald	CBWM/IEUA	3/15/2004	225	0.056	9.92	20	89	10.4	100	0.79	8.2	19	6.8	ND	17	ND	11	94	988	630	1	31
SAR at Archibald	CBWM/IEUA	4/6/2004	210	0.073	9.46	15	85	9.92	98	1.1	8.1	19	7.5	ND	17	ND	11	88	967	618^{A}	1.3	57
SAR at Archibald	CBWM/IEUA	4/27/2004	218	ND	10.1	10	89	10.4	110	0.86	8.2	19	7.9	ND	8	ND	11	94	1000	640^{A}	1.1	17
SAR at HSA	CBWM/IEUA	3/16/2004	216	0.491	9.62	15	86	10.3	98	1.2	8.1	18	6.6	ND	8	ND	12	96	942	603^{A}	1.3	25
SAR at HSA	CBWM/IEUA	4/5/2004	210	0.467	9.44	20	78	9.36	96	1.8	8	17	7.1	ND	17	ND	11	87	992	635^{A}	1.4	44
SAR at HSA	CBWM/IEUA	4/28/2004	211	0.596	9.2	10	83	10	91	1.6	8.2	18	7.8	ND	8	ND	13	93	958	613^{A}	1.4	8.8
SAR at RRXing	CBWM/IEUA	3/16/2004	226	ND	9.23	15	87	9.73	84	0.57	8	18	5.8	ND	4	ND	9.8	84	926	593^{A}	1.1	18
SAR at RRXing	CBWM/IEUA	4/6/2004	218	0.069	8.81	15	81	9.04	79	0.7	8.1	16	5.5	ND	4	ND	11	78	880	563^{A}	1.2	34
SAR at RRXing	CBWM/IEUA	4/27/2004	215	ND	9.05	10	83	9.48	84	0.62	8.2	17	6.5	ND	8	ND	11	84	905	579^{A}	1.2	7.2
SAR at US I15	CBWM/IEUA	3/15/2004	207	0.163	9.37	15	84	10	95	0.81	8.2	18	6.2	ND	17	ND	12	93	960	614^{A}	1.2	32
SAR at US I15	CBWM/IEUA	4/6/2004	201	0.192	9.22	20	80	9.46	96	1.2	8.1	17	7.5	ND	8	ND	11	87	933	597^{A}	1.3	66
SAR at US I15	CBWM/IEUA	4/27/2004	212	ND	9.97	15	87	10.1	110	0.97	8.2	18	7.6	ND	8	ND	12	96	978	626^{A}	1.2	13

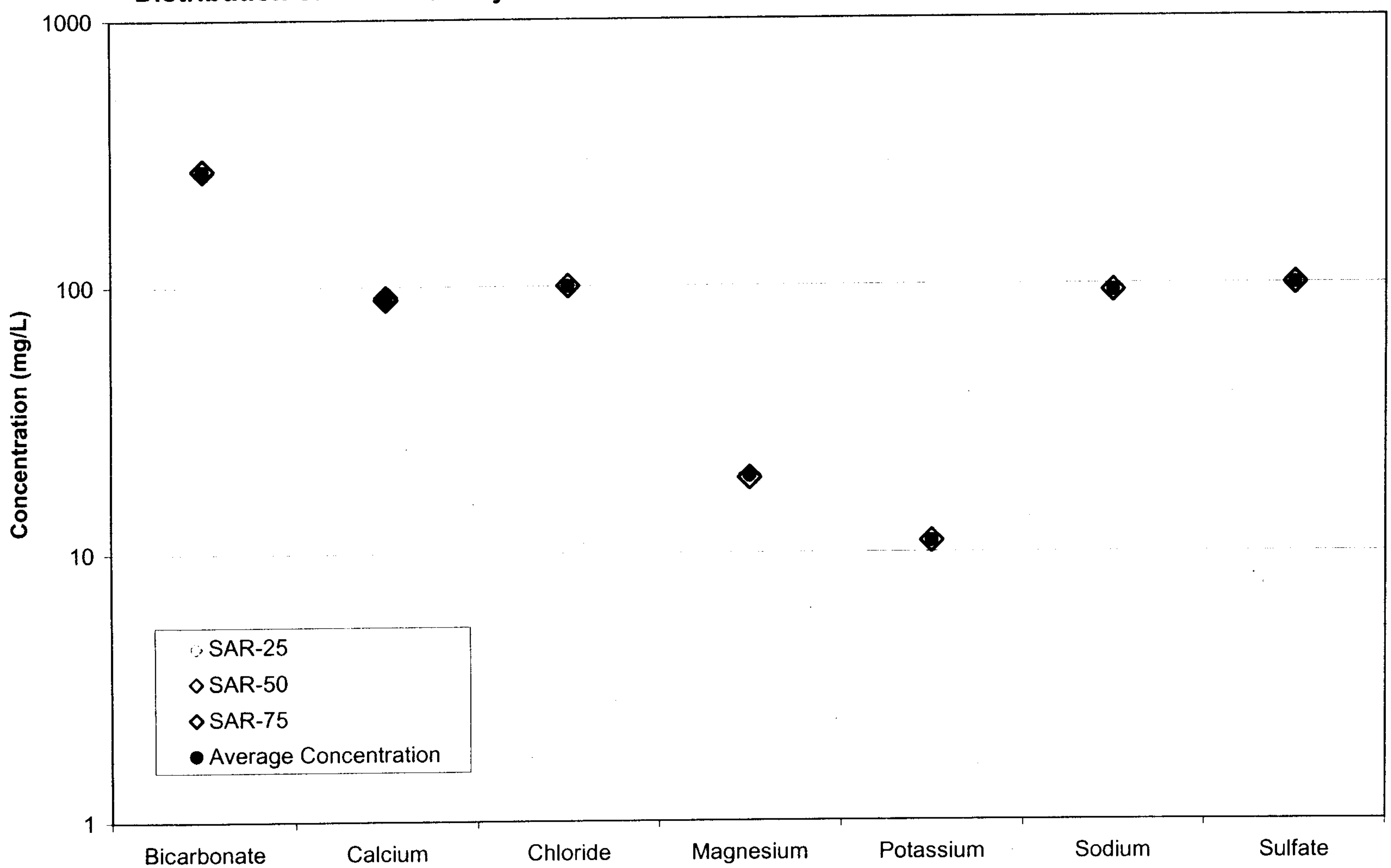
Table 4-2
Nitrogen Concentrations in the Santa Ana River and in Near River Wells

Well	Sample Date	Ammonia as Nitrogen (mg/L)	Kjeldahl Nitrogen (mg/L)	Nitrate as Nitrogen (mg/L)	Nitrite as Nitrogen (µg/L)	Total Nitrogen (mg/L)
Archibald 1	15-Mar-04	ND	ND	70	ND	70
Archibald 1	6-Apr-04	ND	ND	66	ND	66
Archibald 1	27-Apr-04	ND	ND	69	ND	69
Archibald 2	15-Mar-04	ND	ND	80	ND	80
Archibald 2	6-Apr-04	ND	ND	82	ND	82
Archibald 2	27-Apr-04	ND	ND	85	ND	85
HSA 1	16-Mar-04	ND	ND	3.4	ND	3.4
HSA 1	5-Apr-04	ND	ND	3.6	ND	3.6
HSA 1	28-Apr-04	ND	ND	3.6	ND	3.6
HSA 2	16-Mar-04	ND	ND	4.4	ND	4.4
HSA 2	5-Apr-04	ND	ND	4.4	ND	4.4
HSA 2	28-Apr-04	ND	0.22	4.4	ND	4.62
HSA 3	16-Mar-04	0.548	0.79	ND	ND	0.79
HSA 3	5-Apr-04	ND	0.65	ND	ND	0.65
HSA 3	28-Apr-04	0.42	1.1	ND	ND	1.1
RR_Xing	16-Mar-04	ND	0.45	3.7	ND	4.15
RR_Xing	6-Apr-04	ND	0.4	3	ND	3.4
RR_Xing	27-Apr-04	ND	0.34	2.9	0.82	3.24082
US I-15 1	15-Mar-04	ND	2.9	11	ND	13.9
US I-15 1	6-Apr-04	ND	0.42	10	ND	10.42
US I-15 1	27-Apr-04	ND	ND	12	ND	12
US I-15 2	15-Mar-04	ND	5.8	8.2	ND	14
US I-15 2	6-Apr-04	ND	0.38	9	ND	9.38
US I-15 2	27-Apr-04	ND	0.74	9.9	ND	10.64
SARWC 9	16-Mar-04	ND	ND	1.4	ND	1.4
SARWC 9	5-Apr-04	ND	0.22	1.4	ND	1.62
SARWC 9	27-Apr-04	ND	0.23	1.4	ND	1.63
SARWC 11 (top perf)	17-Mar-04	ND	ND	3.1	ND	3.1
SARWC 11 (top perf)	5-Apr-04	ND	1.2	3.2	ND	4.4
SARWC 11 (top perf)	28-Apr-04	ND	ND	3	ND	3
SARWC 11 (bottom perf)	17-Mar-04	ND	ND	3.1	ND	3.1
SARWC 11 (bottom perf)	5-Apr-04	ND	0.21	3.1	ND	3.31
SARWC 11 (bottom perf)	28-Apr-04	ND	0.25	3.1	ND	3.35
SAR at Archibald	15-Mar-04	0.052	0.87	7.2	ND	8.07
SAR at Archibald	15-Mar-04	0.058	0.74	7	ND	7.74
SAR at Archibald	15-Mar-04	0.056	0.79	6.8	ND	7.59
SAR at Archibald	6-Apr-04	0.073	1.1	7.5	ND	8.6
SAR at Archibald	27-Apr-04	ND	0.86	7.9	ND	8.76
SAR at HSA	16-Mar-04	0.491	1.2	6.6	ND	7.8
SAR at HSA	5-Apr-04	0.467	1.8	7.1	ND	8.9
SAR at HSA	28-Apr-04	0.596	1.6	7.8	ND	9.4
SAR at RRXing	16-Mar-04	ND	0.57	5.8	ND	6.37
SAR at RRXing	6-Apr-04	0.069	0.7	5.5	ND	6.2
SAR at RRXing	27-Apr-04	ND	0.62	6.5	ND	7.12
SAR at US I15	15-Mar-04	0.163	0.81	6.2	ND	7.01
SAR at US I15	6-Apr-04	0.192	1.2	7.5	ND	8.7
SAR at US I15	27-Apr-04	ND	0.97	7.6	ND	8.57

Average TN for SAR	7.9	mg/L
Average TN for groundwater[1]	2.6	mg/L
Percentage N-Loss	67.6%	

[1] HSA2, HSA3, SARWC9, SARWC11

Figure 4-1
Distribution of Water Quality Results for the Santa Ana River Archibald Site on March 15, 2004



5. COST ESTIMATE

A planning level cost estimate to complete twelve months of the N-Loss Monitoring Program was developed. The following assumptions were made:

- sample monthly
- sample 10 wells (Archibald 1, Archibald 2, US I-15 #1, US I-15#2, HSA 1, HSA 2, HSA 3,RRXing, SARWC 9, SARWC 11
- sample 4 surface water stations (Archibald, US I-15, HAS, RRXing)

The estimated cost to conduct this monitoring program is $132,000 (Table 5-1).

Table 5-1

Planning Level Cost Estimate for Demonstration of Nitrogen Loss in the Santa Ana River

Tasks		Labor Cost	ODCs Subtotal	Total Cost
1	**Develop Scoping Documents Describing Methodologies**			
1.1	Draft Scoping Document			
1.2	Final Scoping Document			
2	**Prepare Monitoring Program Work Plan**	**$5,952**	**$1,000**	**$6,952**
2.1	Draft Work Plan			
2.2	Final Work Plan	$5,952	$1,000	
3	**Conduct Monitoring Program**	**$38,880**	**$53,400**	**$92,280**
3.1	NAWQA/SARWC/SAR Well Sampling	$27,360	$7,200	
3.2	Laboratory		$46,200	
3.3	Data Upload	$11,520		
4	**Technical Memorandum**	**$21,824**	**$2,000**	**$23,824**
4.1	Draft Technical Memorandum	$16,472	$1,000	
4.2	Final Technical Memorandum	$5,352	$1,000	
5	**Attend Technical Advisory Committee Meetings**	**$6,256**	**$2,546**	**$8,802**
5.1	Prepare for and Attend Meetings	$6,256	$2,546	
Totals		**$72,912**	**$58,946**	**$131,858**

6. REPORTING

Quarterly progress reports will be prepared the Task Force consultant. Comments from Task Force members will be discussed at quarterly meetings to be held between 2 to 4 weeks after the submittal of the quarterly reports. Potential changes to the N-loss monitoring program will be addressed, as warranted, based on the sample results and data generated during each of the quarters. A draft and final annual technical report summarizing the results of the N-loss monitoring program will be completed in spring 2006. The draft report will be submitted to the RWQCB, the Task Force, all other affected public, and private agencies, and interested parties for comment. This report will contain pertinent tables, figures, and maps, including detailed water quality and water level contour maps based on the collected water quality and water level data collected. All relevant data will be included in a Microsoft (MS) Access database appended to the report on a compact disk. All relevant comments will be addressed and incorporated into the final report, as appropriate.

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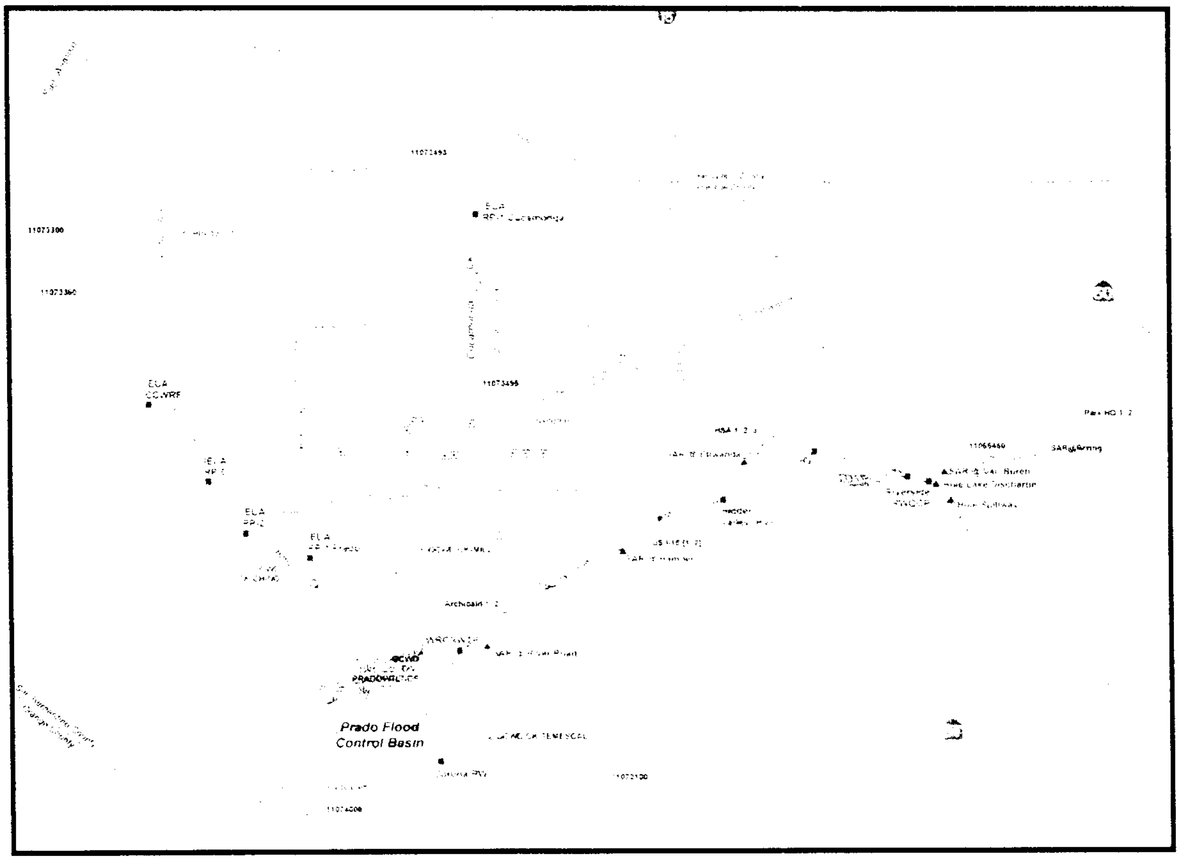
7/15/04

Santa Ana Watershed

BASIN MONITORING PROGRAM

Demonstration of Nitrogen Loss in Reach 3 of the Santa Ana River

Addendum to Draft Work Plan



Prepared for

Basin Monitoring Program Task Force

Prepared by

Wildermuth Environmental, Inc.

July 2004

OBJECTIVE

The objective of this addendum is to modify the *Draft Work Plan for the Demonstration of Nitrogen Loss in Reach 3 of the Santa Ana River* (WEI, 2004) to coordinate the surface water sampling program for demonstration of nitrogen loss with the Hydraulic Control Monitoring Program (HCMP) along Reach 3 of the Santa Ana River. Because of the overlap in scope and geographic location of these programs, they can be synchronized such that there will be a cost savings in terms of both labor and analytical costs with no compromise in data integrity or robustness.

BACKGROUND

As part of the Nitrogen Loss in Reach 3 of the Santa Ana River Study, five US Geological Survey (USGS) National Water Quality Assessment (NAWQA)wells and their corresponding surface water sites have been sampled monthly beginning March 15, 2004 (WEI, 2004). Watermaster and the Inland Empire Utilities Agency (IEUA), as part of the Hydraulic Control Monitoring Plan, have been collecting surface water samples bi-monthly at sites in close proximity to the NAWQA sites. The locations of these sites are shown in Figure 1. It is proposed that these sampling programs be coordinated and that the surface water samples collected from the HCMP sites be used to represent the corresponding NAWQA sites. The combination of these efforts will result in a cost savings to the agencies involved.

DISCUSSION

The proposed pairs to share surface water quality data are SAR@River Road and SAR@Archibald, SAR@Hamner and SAR@US I-15, SAR@Etiwanda and SAR@HSA, and SAR@Van Buren and SAR@RRXing. These pairs are shown grouped together within red-outlined boxes in Figure 1.

Figures 2 through 5 show nitrate concentrations at the four locations along Reach 3 of the Santa Ana River. At all four locations nitrate concentrations are comparable at the HCMP and N-Loss Monitoring Program sites. Nitrate is shown here instead of Total Nitrogen (TN) because Total Kjeldahl Nitrogen (TKN) was not analyzed on the HCMP samples. It is not expected that TKN values would greatly differ between sites at the same location. In the future, HCMP samples will be analyzed for the same constituents as outlined in the Draft Work Plan (Table 1).

Table 1
List of Analytes for Surface Water Analyses in N-Loss Study

Analytes	Method
Alkalinity (Bicarbonate)	EPA 310.1/SM 2320B
Apparent Color	SM 2120B
ClO_4	EPA 314
Major anions: Cl, SO_4, NO_2, NO_3	EPA 300.0
Major cations: K, Na, Ca, Mg,	EPA 200.7
NH_3	EPA 350.1
Odor	SM 2150B
pH	EPA 150.1/SM 4500-HB

Table 1
List of Analytes for Surface Water Analyses in N-Loss Study

Analytes	Method
Specific Conductance	SM2510B
TDS	EPA 160.1/SM 2540C
Total Kjeldahl Nitrogen (TKN)	EPA 351.4
Total Phosphorus	EPA 365.1
Turbidity	EPA 180.1

Table 2 shows the estimated travel time between the paired sites at all four locations. The greatest travel time occurs at RRXing, exceeding one hour. However, the typical travel time is approximately 30 minutes between sites. This amount of time does not allow for any significant changes in water quality to occur.

Table 2
Travel Time Between Paired Sites

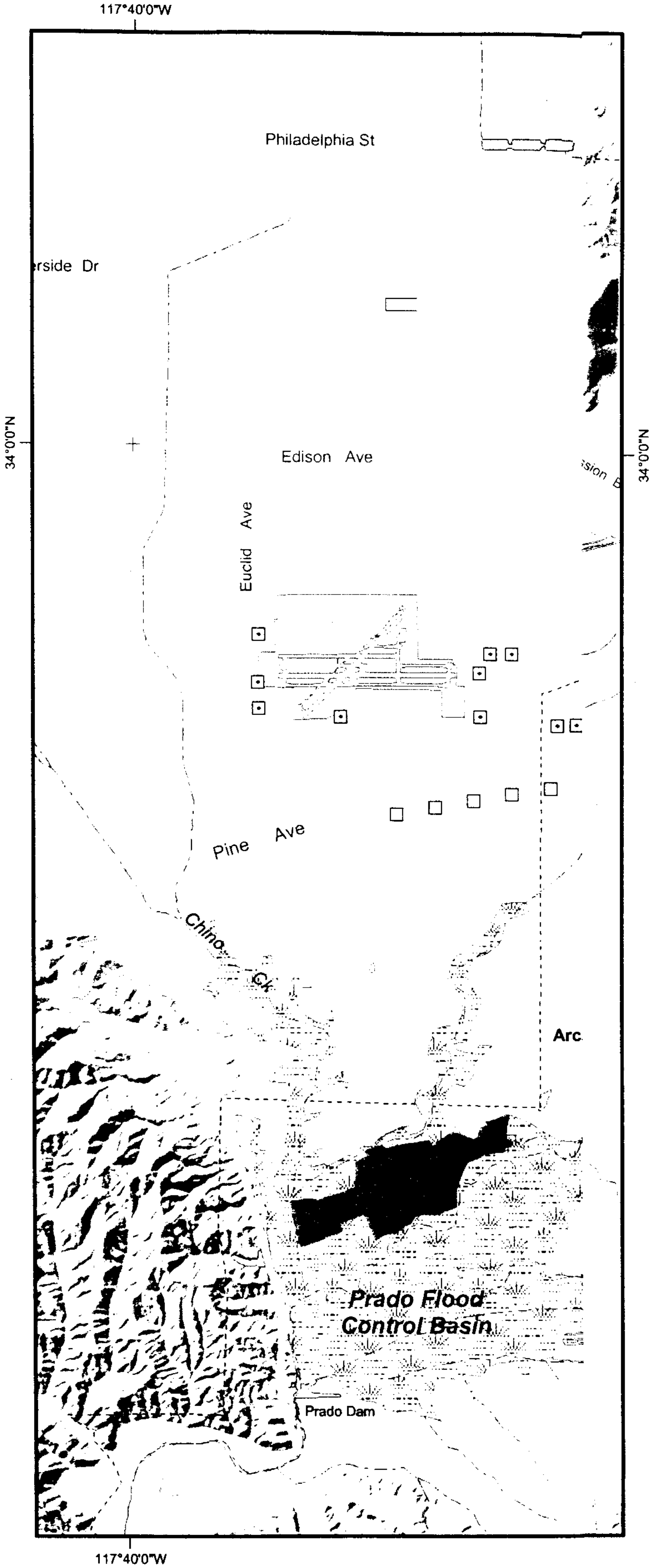
Location	Distance Between Sites (ft)	Velocity of Middle Third (ft/sec)	Travel Time (min)
RRXing	9186	1.89	81
HSA	3051	1.70	30
US I-15	2132	1.47	24
Archibald	2985	1.55	32

COST SAVINGS

The elimination of sampling four sites monthly will result in an estimated annual savings of $13,166.

REFERENCE

Wildermuth Environmental, Inc. 2004. Draft Work Plan for the Demonstration of Nitrogen Loss in Reach 3 of the Santa Ana River. *Prepared for the Basin Monitoring Task Force.* Revised June 18, 2004



Main Map Features

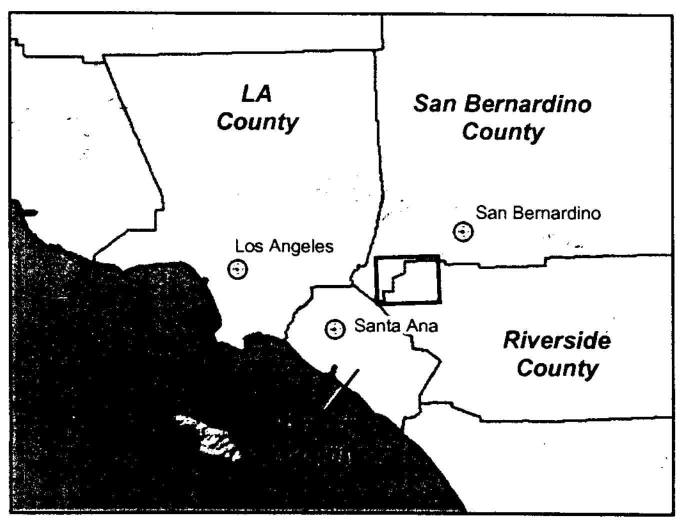
- Ad Hoc Surface Water Station -- HCMP
- USGS SAR-NAQWA Wells
- Santa Ana River Water Company Wells
- Existing Desalter-1 Well
- Future Desalter Well (planned location)

Other Features

- Flood Control and/or Conservation Basin
- OCWD Duck Ponds
- SAR Phreatophytes

Geology

- Unconsolidated Sediments
- Consolidated Bedrock



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Location of Surface Water Stations Used in N-Loss Studies

Figure 1

Figure 4
SAR @ Horse Staging Area

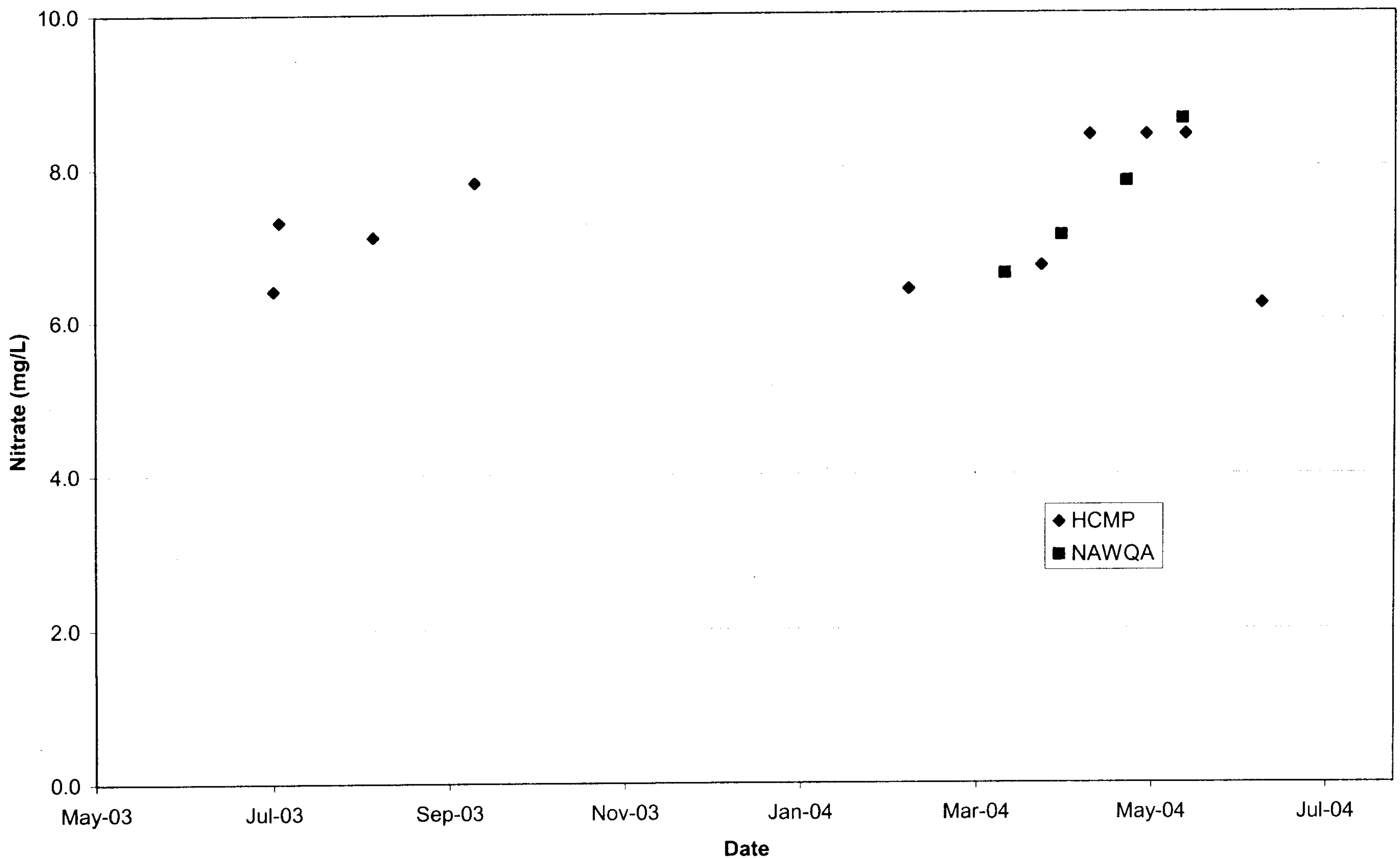


Figure 5

SAR @ Railroad Crossing

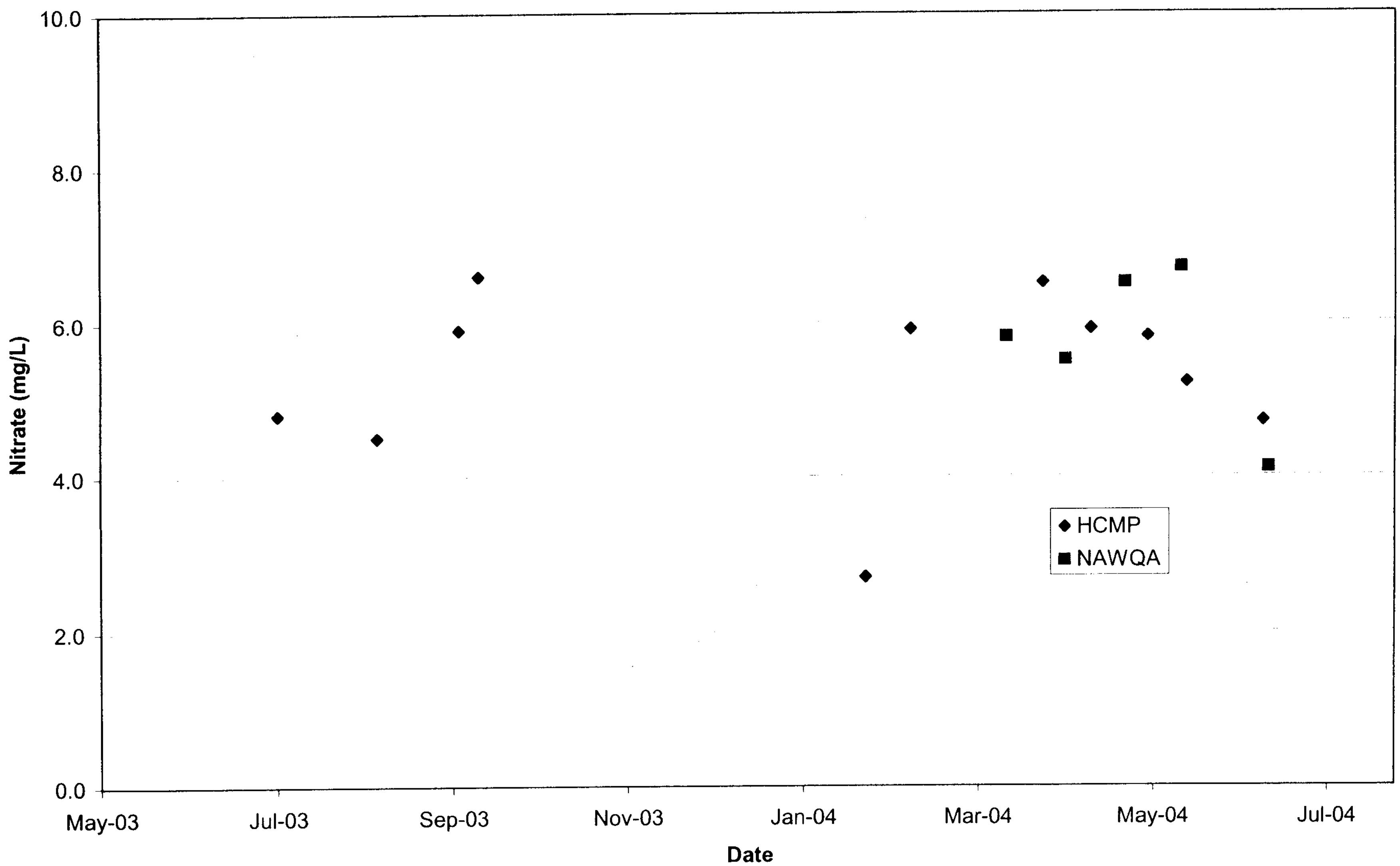


Figure 2

SAR @ Archibald

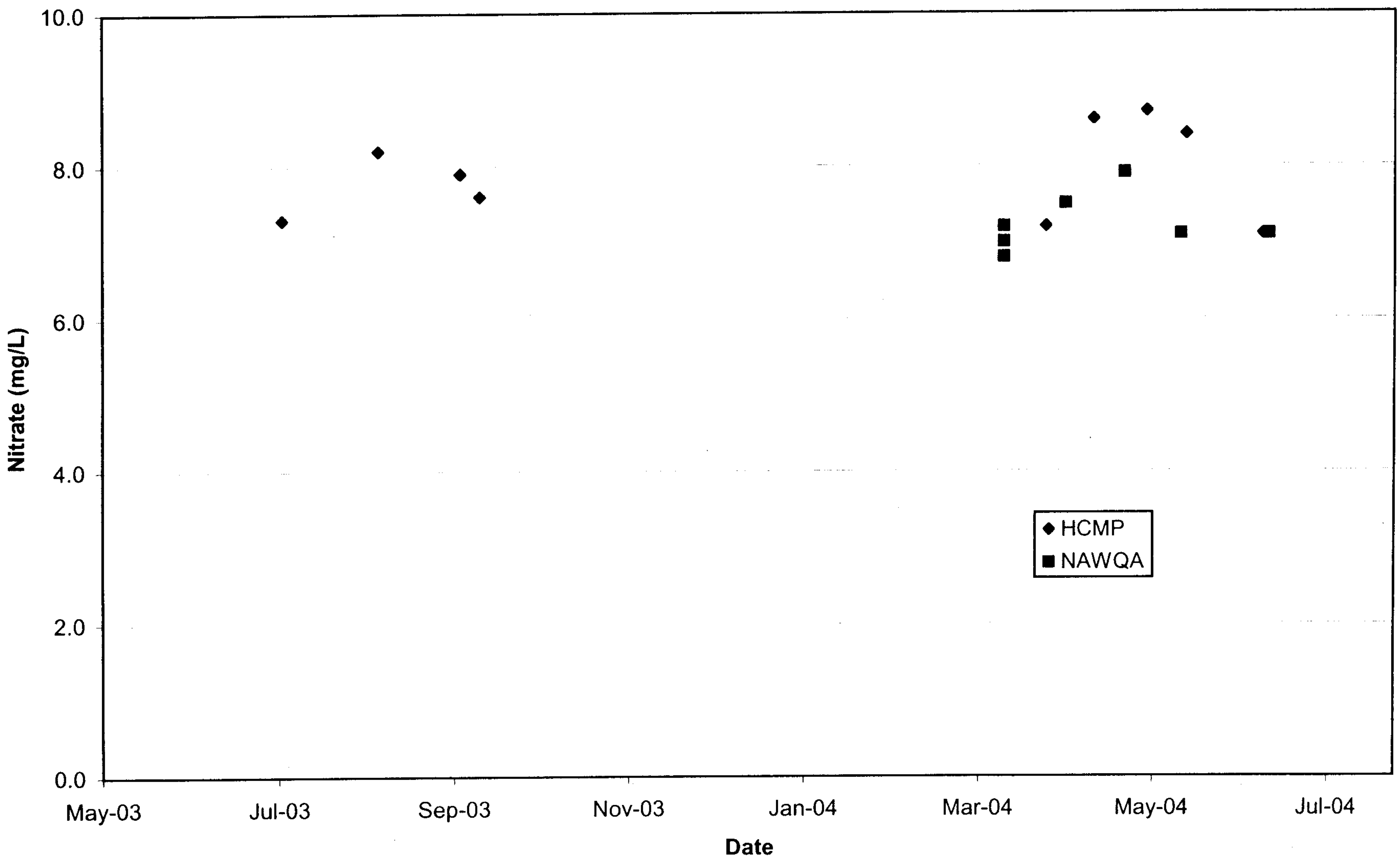
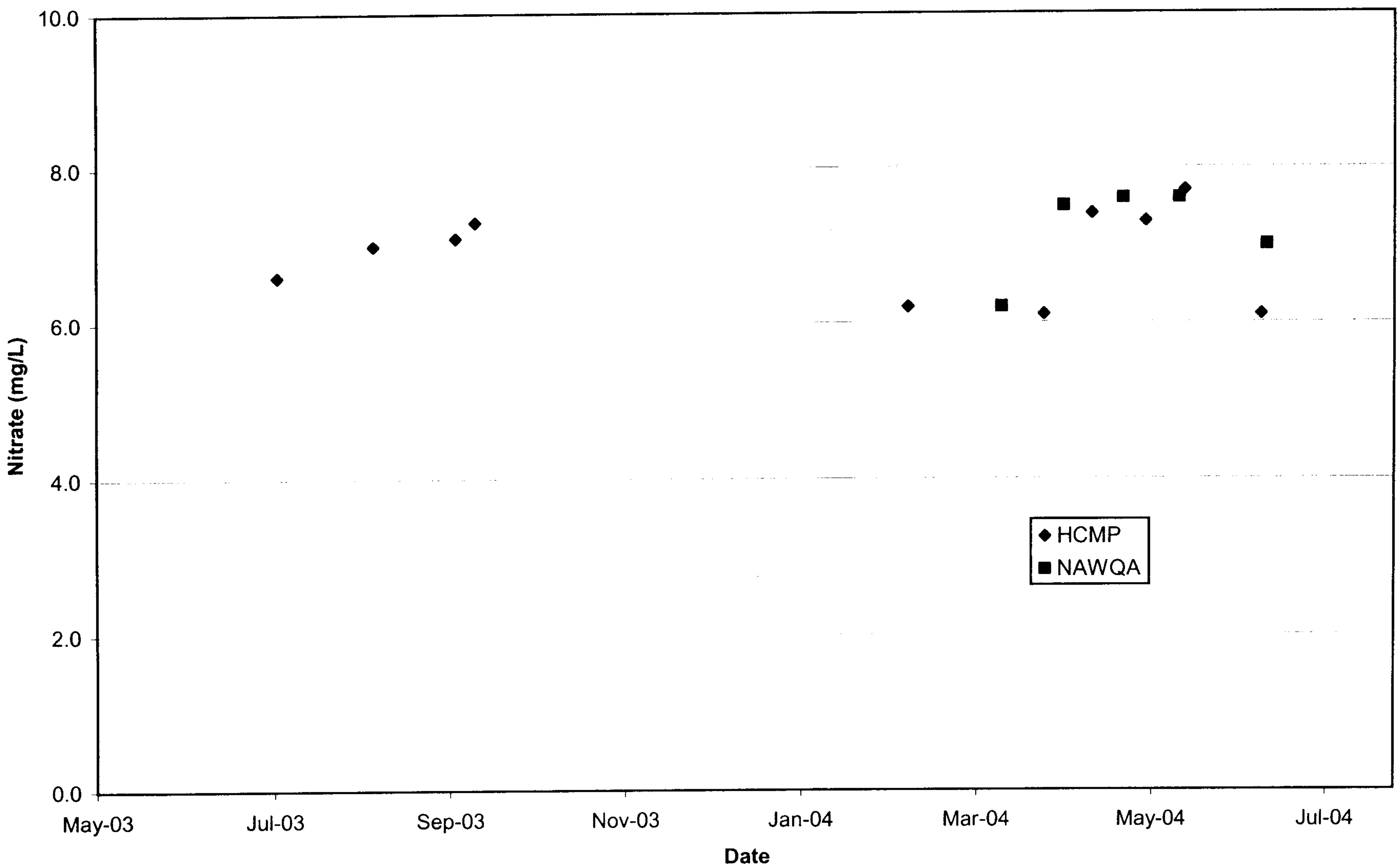


Figure 3

SAR @ US I-15



January 28, 2005

Santa Ana Watershed Project Authority
Attn: Mark Norton
11615 Sterling Avenue
Riverside, CA 92503

SUBJECT: SANTA ANA RIVER WATER QUALITY WORK PLAN

INTRODUCTION

As part of the agreement to adopt the 2003/2004 Basin Plan amendment, affected parties have agreed to the following monitoring programs and analyses:

- A. Recomputation of Ambient Water Quality for the Period 1984 to 2003;
- B. Preparation of an Annual Report of Santa Ana River Water Quality; and
- C. Demonstration of Nitrogen Loss in Reach 3 of the Santa Ana River:

Implementation of a surface water monitoring program is needed to determine compliance with the nitrogen and TDS objectives of the Santa Ana River, and thereby, the effectiveness of the wasteload allocations. It is also needed to provide data required to evaluate the effects of surface water discharges on affected groundwater management zones. In particular, data are needed to confirm the validity of the 50 percent nitrogen loss coefficient that will be applied in regulating discharges to that part of Reach 3 of the River that overlies the Chino South groundwater management zone.

Chapter 4 of the Basin Plan specifies baseflow TDS and total nitrogen objectives for Reach 3 of the River. For Reach 2, a TDS objective based on a five-year moving average of the annual TDS concentration is specified. Use of this moving average allows the effects of wet and dry years to be integrated over the five-year period and reflects the actual long-term quality of water recharged by Orange County Water District downstream of Prado Dam.

The Basin Plan specifies a monitoring program to determine compliance with the Reach 3 baseflow objectives at Prado Dam (see Chapter 4). Regional Board staff conducts this program on an annual basis. Measurement of baseflow quality, rather than the quality of flows in Reach 2, has long been used to indicate the effects of recharge of Santa Ana River flows on Orange County groundwater. The efficacy of this approach was evaluated as part of the 2004 update of the TDS/nitrogen management plan in the Basin Plan. Insufficient data were available to draw a direct correlation between the long-term TDS and nitrogen quality of River flows at Prado Dam and that of affected Orange County groundwater. However, the conclusion drawn by the N/TDS Task Force was that reliance on the Reach 3 baseflow objectives to protect Orange County groundwater, and the existing monitoring program designed to measure compliance, is adequate.

In addition to this baseflow sampling program and the surface water monitoring commitments associated with certain agencies' "maximum benefit" programs, the comprehensive monitoring program to be proposed and implemented by the Task Force members, and other agencies as appropriate, must include an evaluation of compliance with the TDS and nitrogen objectives for Reaches 2, 4, and 5 of the Santa Ana River. Compliance with the Reach 2 TDS objective can be determined by evaluation of data collected by the Santa Ana River Watermaster, Orange County Water District, the United States Geological Survey, and others.

Task 1. Agency Coordination

On behalf of Orange County Water District, Inland Empire Utilities Agency, Chino Basin Watermaster, City of Riverside, City of Corona, Elsinore Valley Municipal Water District, Eastern Municipal Water District, City of Colton, City of San Bernardino Municipal Water Department, City of Redlands, Jurupa Community Services District, Western Riverside County Regional Wastewater Authority, Lee Lake Water District, Yucaipa Valley Water District, City of Beaumont, the San Timoteo Watershed Management Authority and the City of Rialto, an annual report of Santa Ana River, Reaches 2, 4, and 5 water quality will be prepared that will provide an evaluation of compliance with the TDS and nitrogen objectives for Reaches 2, 4, and 5 of the Santa Ana River to be submitted to the Regional Board.

Task 2. Data Collection

The RWQCB staff conducts an annual monitoring program over a four week period during the months of August and September to determine compliance with Reach 3 baseflow objectives at Prado Dam. Compliance with water quality objectives for Reaches 2, 4, and 5 will be determined from data collected by the following agencies. Figure 1 shows the location of surface water sample stations for the following agencies and recycled water discharge sites.

Task 2.1 Orange County Water District

Orange County Water District (OCWD) collects water quality samples along the Santa Ana River, above and below Prado Dam, and its tributaries on a quarterly basis, with greater sampling frequency during the month of August. These data will be provided by OCWD and used to evaluate water quality for Reaches 2 and 3 of the Santa Ana River.

Task 2.2 United States Geological Survey

The United States Geological Survey (USGS) collects stream flow measurements and water quality samples along the Santa Ana River. Long-term streamflow and water quality data sets are available for gaging station 11074000, At Below Prado Dam, and gaging station 11066460, At MWD Crossing. Data from other gaging stations will be used as necessary. These data are readily accessible via the USGS website.

Task 2.3 Santa Ana River Watermaster

The Santa Ana River (SAR) Watermaster compiles data on an annual basis from the USGS, City of Riverside, OCWD, Eastern Municipal Water District (EMWD), Western Municipal Water District (WMWD), the Santa Ana Watershed Project Authority (SAWPA), and other dischargers to the Santa Ana Rivers. Current data that have not been published by the SAR Watermaster will be collected directly from the source agency.

Task 2.4 Other Sources

Where available, all other relevant surface water quality and stage/flow data will be collected, such as the data generated by the Hydraulic Control Monitoring Program (HCMP). The HCMP is being conducted by IEUA and Chino Basin Watermaster as part of their Maximum Benefit monitoring commitment.

Task 3. Data Analysis

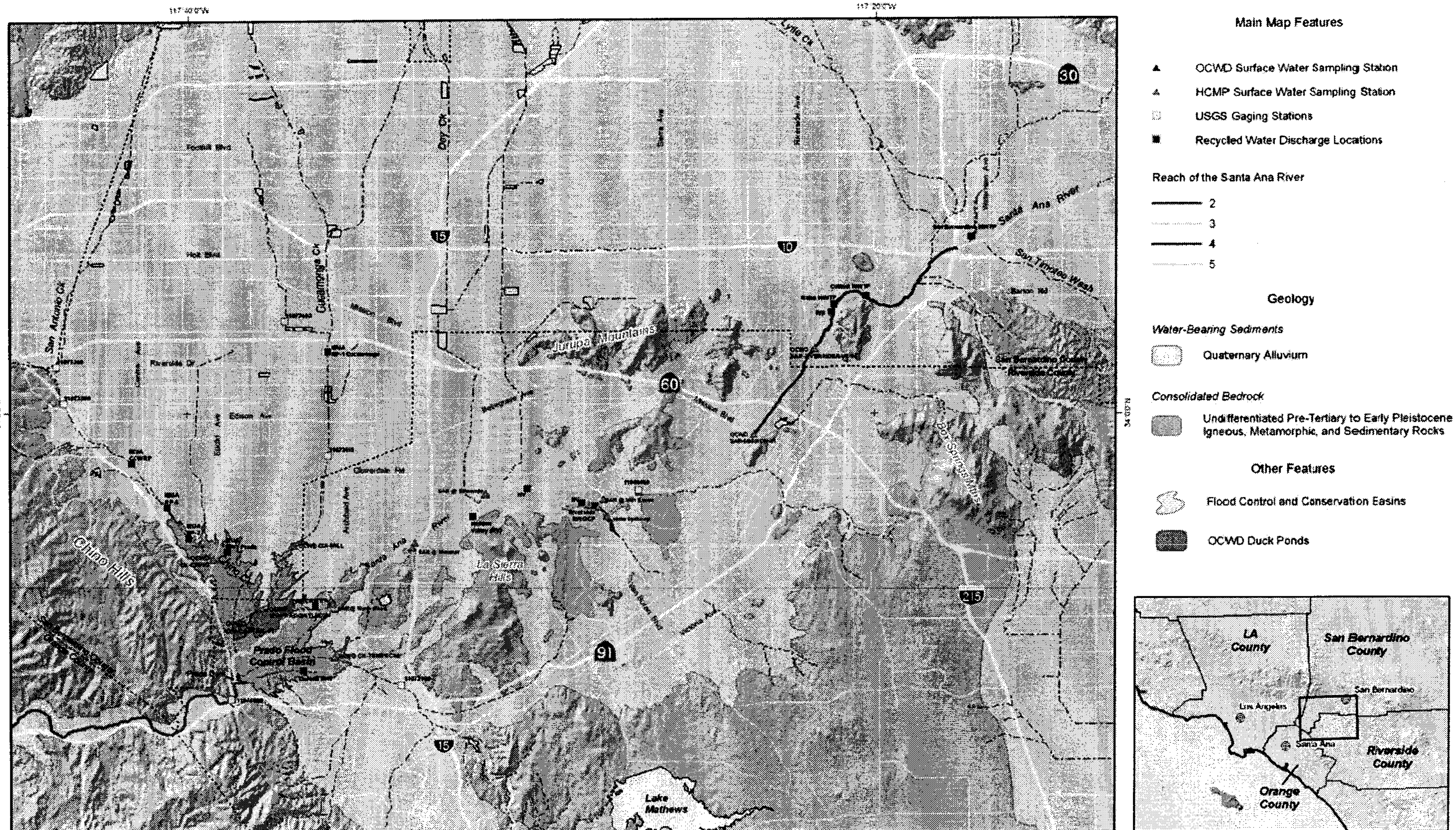
Tables and figures will be constructed for all constituents for which there are results (including TDS, nitrogen species, TOC, *et cetera*). Time histories will be plotted for TDS, TIN, and other constituents, as the data warrant. In addition to the "raw data," the time histories will also have the 5-year moving averages for these constituents to show longer-term trends in the data. Please see Table 1 and Figures 2 and 3 for examples of the tables and figures described above.

Changes in nitrogen and TDS concentrations will also be analyzed for in the diverted portion of the Santa Ana River that flows through the Prado wetlands.

Additionally, results will be compared to nitrogen and TDS objectives for Reaches 2, 3, 4, and 5 of the Santa Ana River.

Task 4. Report Preparation

A draft technical memorandum summarizing the results of the data collection and analyses will be prepared. The report will contain an Appendix on a compact disk that contains a digital copy of the technical memorandum. Also included on the CD will be an Access database containing all data used in the analyses. The draft report will be submitted to the SAWPA TAC, the RWQCB, all other affected public agencies, and interested parties for comment. This report will contain pertinent tables, figures, and maps. Comments from all parties will be addressed in a final report, with the comments and responses included as an appendix to the final report.



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Santa Ana River Annual Report

Location of Recycled Water Discharge and Surface Water Sampling Stations

Figure 1

Figure 2
TDS and Components of Flow at Below Prado Dam

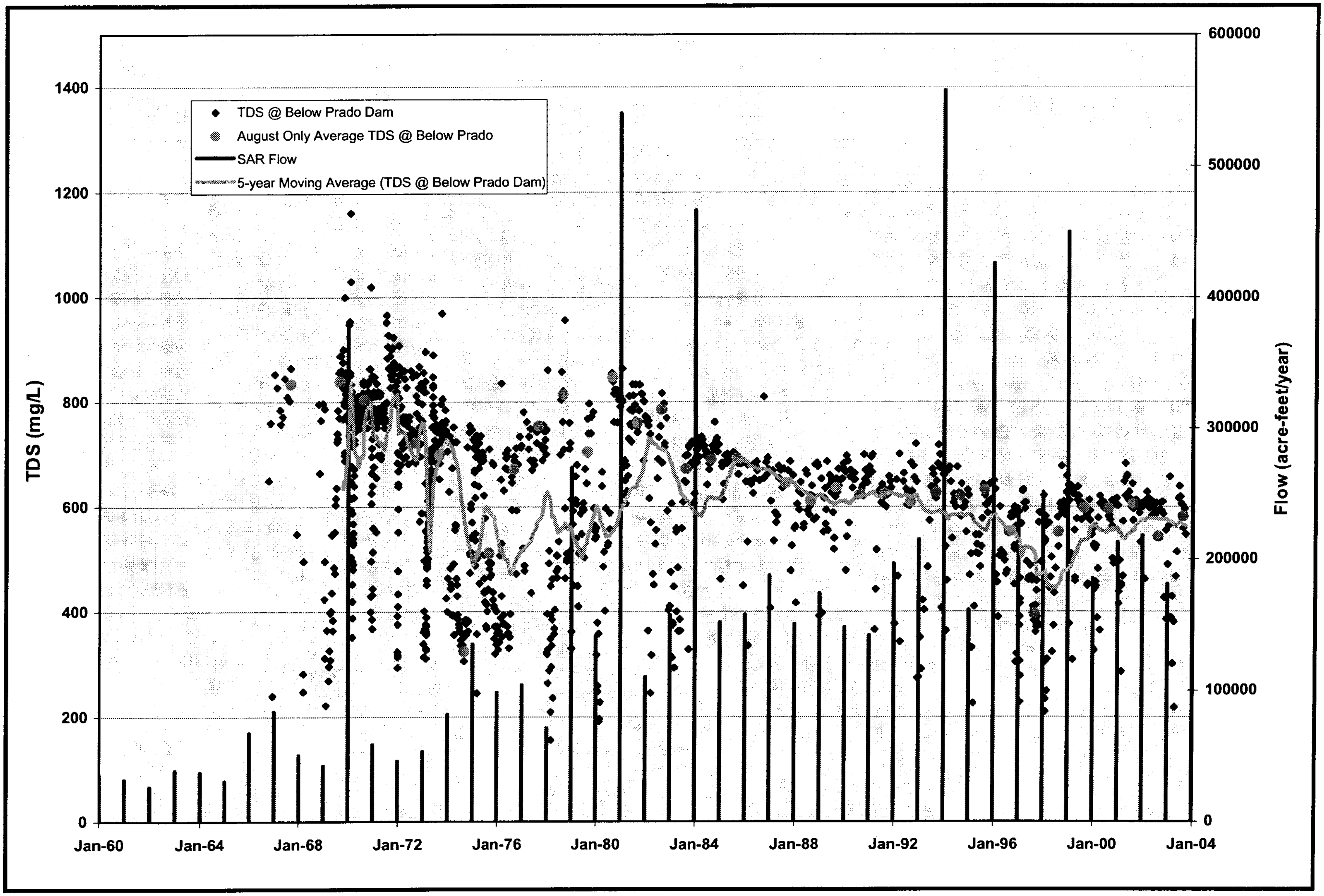

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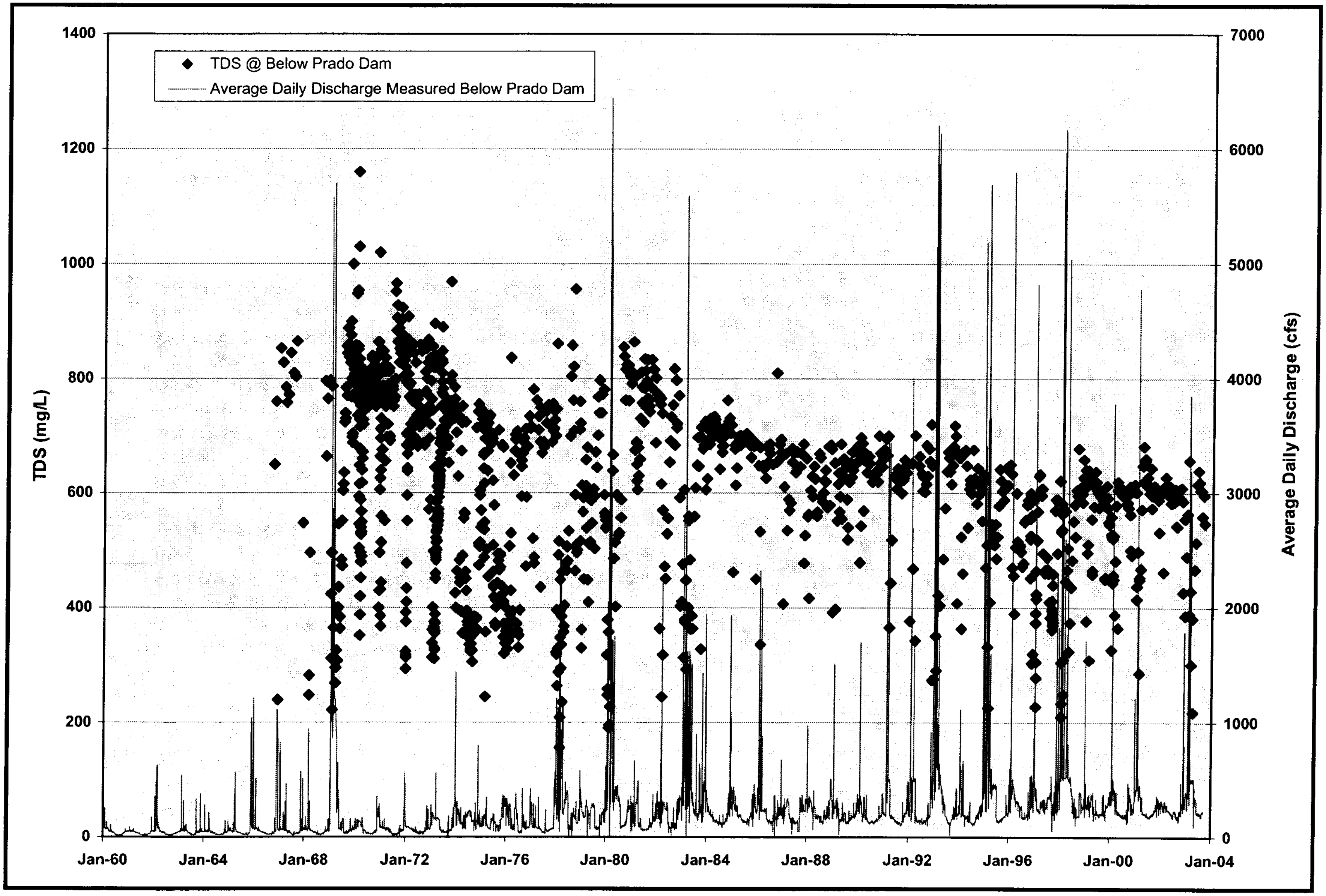
Figure 3
TDS and Average Daily Discharge at Below Prado Dam



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